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IN ALL ITS APPLICATIONS TO

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EDITED BY

WILLIAM CROOKES, F.R.S., &c.

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THE CHEMICAL NEWS.

VOLUME XLIX.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1258.—JANUARY 4, 1884.

PECULIAR ABSORPTION OF A COMPOUND OF IODINE BY ALUMINIUM.*

By Dr. G. GORE F.R.S.

A PIECE of clean sheet aluminium 2½ inches long and 2 inches wide, and weighing about 20 grains, was divided into two equal portions:—One of them, together with a sheet of platinum, was immersed in a colourless solution of 17½ grains of pure iodic acid in 3½ ounces of water, so as to form a voltaic pair, and the other was wholly immersed in a similar portion of the same liquid in a separate and similar glass vessel, and both were kept at the atmospheric temperature. The current from the voltaic couple was passed by means of a small silver anode, and a much smaller silver cathode, through a plating solution of argentic cyanide containing the minimum practical amount of free cyanide of potassium in order to obtain the maximum amount of silver deposit.

The plates were immersed three hours. During that period, gas was evolved in moderate quantity from each aluminium plate, but none visibly from the platinum one. An electric current was produced, and silver freely deposited. The liquids gradually became strongly coloured by liberated iodine, and apparently to the same extent.

At the end of the above period, the aluminium plates and the silver cathode were taken out. Each of the former plates had become very rough and corroded in vertical grooves through the influence of the ascending streams of gas, but no deposit of iodine or oxide appeared upon them; their surfaces were metallic and bright. The three plates were thoroughly washed in cold water, dried between sheets of hot filter-paper, and weighed. During the washing iodine came freely out of the aluminium ones, but no alumina was visible. The weight of silver deposited was 1·30 grains, equal to 0·110 grain of the positive aluminium plate dissolved to produce the current, and to 2·03 grains of iodine liberated by the hydrogen set free at the platinum plate.

Notwithstanding that the plates were both of them evidently much corroded, the positive one being probably the most so, and that much iodine had been extracted from each plate by the process of washing, they had each gained in weight 1·30 grain. By further repeated immersion alternately in cold and in boiling water, the gain of weight of each was reduced to 1·10 grain. The dry plates were then immersed in bisulphide of carbon in a closed vessel during 36 hours at 16° C., but not a trace of colour was produced in the liquid. After evaporation of the bisulphide by exposure to the air, the plates still emitted an odour of iodine.

A sheet of aluminium was also immersed during fourteen hours in a cold saturated solution of iodine in water. No corrosion of the metal took place, and no signs of absorption of iodine were observable. The absorption in the previous experiments was therefore probably due to the action of hydrogen setting free nascent iodine at the absorbing surface.

A sheet of aluminium was freely corroded in dilute hydrochloric acid, containing dissolved iodine, during one and a half hour, but no iodine was absorbed.

A solution of iodine in dilute sulphuric acid was slowly electrolysed during three hours by a current from two cells of zinc and platinum in that dilute acid, with electrodes of sheet aluminium. Gas was evolved; most at the cathode. No iodine was absorbed.

A colourless solution of potassic iodide was electrolysed during the same time in the same manner. Gas was set free, chiefly at the cathode. The liquid remained colourless. A very small amount of iodine was absorbed by the anode.

A colourless solution of potassic iodate was similarly treated during two hours. The liquid around the cathode became immediately coloured with iodine, and after a time that around the anode also became slightly coloured. The anode lost 0·041 grain in weight, and the cathode 0·126 grain. The anode alone absorbed a minute amount of iodine.

An equivalent quantity of bromate of barium, in fine powder, was mixed with some dilute sulphuric acid, and allowed to digest, with occasional stirring, during nineteen hours. A sheet of aluminium was then immersed in the clear liquid; hydrogen was evolved; bromine was set free and coloured the liquid, but the application of various tests revealed only feeble signs of bromine having been absorbed by the metal.

In another experiment, a sheet of the metal, two inches long and two inches wide, and weighing 15·752 grains, was immersed during about three hours in five ounces of water containing 25·749 grains of dry iodic acid, the solution being at about 16° C. Much gas was evolved, the metal gained 1·273 grain in weight, and evolved a strong odour of iodine. It was then completely dissolved in hot dilute hydrochloric acid, and the amount of metal in the solution determined by means of ammonic chloride and ammonia in the usual manner. The amount of aluminium thus found was 14·685 grain. The quantity of metal therefore which had dissolved in the solution of iodic acid was 1·066 grains, and the amount of substance, apparently iodine only, absorbed by the remaining 14·685 grains of metal, was 2·340 grains, or 15·93 per cent of its weight.

* Read before the Birmingham Philosophical Society, December 13th, 1883.

A thin sheet of the metal became very slightly corroded by immersion during five hours in a mixture of dilute sulphuric acid, and a solution of potassic iodide, but showed no signs of absorption.

In dilute aqueous hydriodic acid containing dissolved iodine, the metal was rapidly corroded, but in two hours had only absorbed a trace of iodine. The sheets were, however, disintegrated. By fracturing them the odour of iodine was much more distinct. By enclosing the sheets either wet or dry in corked glass tubes during twenty-four hours, the odour was not increased.

By examining under a microscope, a sheet which had been immersed in the aqueous iodic acid, it was found to be partly disintegrated into thin layers.

These various results point towards the inference, that the absorption of the iodine compound occurred when that substance was set free in the nascent state at the corroding surface of the aluminium. The case appears to be somewhat similar to that of absorption of nascent hydrogen by palladium.

A thin and straight sheet of aluminium, coated on one side with shellac, and caused to absorb the maximum amount of iodine in the manner already described, did not become curved.

A chemical analysis of the absorbed substance has not yet been made.

ON THE CONSTITUTION OF CHLOROPHYLL.*

By EDWARD SCHUNCK, F.R.S.

AN examination of some products derived from chlorophyll, which has occupied me for some time, has led to the question of the true nature and constitution of chlorophyll, a question on which widely different opinions prevail. Without entering into matters which concern the physiologist only, it may be said that to the chemist chlorophyll is simply an organic colouring-matter, the substance to which the green colour of leaves and other parts of plants is due. Now colouring-matters are of three kinds. To the first class belong such as occur ready formed and in a free state in vegetable and animal organisms, such as the colouring-matters of turmeric and safflower. The second class comprises those that are formed from colourless chromogens by the combined action of alkalies and oxygen, the colouring-matters of logwood and archil being well-known examples of this class. These colouring-matters change rapidly when exposed to the further action of oxygen in the presence of alkali, but are quite stable when in contact with acids. The third class consists of glucosides, bodies which do not undergo any considerable change under the influence of alkalies, but are rapidly decomposed when acted on by acids or ferments, yielding, on the one hand, some kind of glucose, and, on the other, substances in which the tinctorial properties of the parent substance are much more pronounced. To this division belong the colouring-matters of madder, quercitron, cochineal, &c. Now chlorophyll in its general properties so much resembles the members of the last class that one cannot help suspecting that to this class it may belong—that it is, in fact, a glucoside. It shows considerable stability in the presence of alkalies, but acids decompose it rapidly, giving rise to substances which are intensely coloured and show a power of absorbing particular parts of the spectrum much more strongly than chlorophyll itself. Whether, along with the latter bodies, it yields by decomposition with acids some kind of glucose seemed to me a question worthy of attention.

If it was possible to obtain chlorophyll in a state of purity it would be very easy to settle this question; unfortunately all attempts hitherto made to separate and purify chlorophyll have ended in its decomposition. I consider it as certain that the so-called crystallised chlorophyll which has been described by several authors is in fact a derivative of chlorophyll formed during the process employed for preparing it. It is, however, very easy to obtain a solution of chlorophyll which shall be quite free from everything soluble in water extracted at the same time from the plant, and therefore free from ready-formed glucose. In order to effect this I proceed as follows:—Having extracted leaves of any kind with boiling alcohol, I allow the extract to stand for some time, filter off the deposit which usually forms, and then mix it with its own volume of ether and with about two volumes of water, shaking up well. The liquid now separates into two layers, an upper green one, containing all the chlorophyll of the extract, and a lower bright yellow one, which contains tannin, a yellow colouring-matter, a substance giving the glucose reaction with Fehling's solution, and probably other substances besides. The two liquids are separated in the usual way, and the upper one is shaken up with fresh water, which now usually only shows a trace of colour. This process of washing may be repeated, adding each time a little fresh ether, until the lower layer ceases to give the glucose reaction. The upper liquid leaves on spontaneous evaporation a bright green residue, which, though far from being pure chlorophyll, is free from everything soluble in water, and may therefore be employed to determine whether anything soluble in water, such as glucose, is formed by the action of acids on it. If some of the residue be treated with concentrated sulphuric acid in the cold it dissolves, forming a green solution, which, after standing for some time, gives, on the addition of water, a dark green precipitate. This precipitate consists essentially of two substances, the phyllocyanin and phylloxanthin of Frémy, which are undoubtedly products derived from chlorophyll, showing the absorption-bands of what is usually called "acid chlorophyll." The liquid filtered from this precipitate, when mixed with copper sulphate and an excess of caustic alkali, becomes blue, and the mixture, on boiling, deposits cuprous oxide. The experiment may be made in a slightly different manner. The residue left by the green ethereal solution of chlorophyll having been dissolved in alcohol, sulphuric or hydrochloric acid is added to the solution, which is then boiled for some time, evaporated so far as to drive off most of the alcohol, filtered from the products insoluble in water, made alkaline, then mixed with Fehling's solution and boiled, when the usual glucose reaction takes place. In order to make sure that the reaction was not due to ready-formed glucose, I took in every case the precaution of testing a portion of the green chlorophyllic residue with Fehling's solution before acting on the rest with acid. This was easily done by treating with weak alcohol, to which a little alcoholic potash and some Fehling's solution were added, and heating, when the whole dissolved easily, giving a green solution, which, on boiling, in no case deposited the least trace of cuprous oxide, whereas, after adding an excess of hydrochloric acid to the liquid, boiling, filtering off the insoluble products, again making alkaline and boiling, the glucose reaction took place in a marked manner.

This experiment has never in any case failed, and it would follow, if uniformly successful, that the green leaves of all plants contain a glucoside insoluble in water, but soluble in alcohol and ether. That this glucoside is, in fact, chlorophyll seems to me highly probable. Nevertheless, absolute certainty cannot be attained, because the matter experimented on is a mixture, and it is possible that one plant out of many might give a decidedly negative result, which would upset the conclusion drawn from the rest. Assuming, however, that the phenomena will always occur as above described, and that the reaction with Fehling's solution indicates the presence of some kind of glucose, it would follow either that chlorophyll is a glucoside or that it is always accompanied in the vegetable cell by a glucoside of very similar properties.

I may add that I attempted to isolate the glucose or glucose-like substance formed under the circumstances

* A Paper read before the Royal Society, Dec. 20th, 1883.

described, spinach leaves being the material employed, and obtained a pale yellow gum-like substance which showed no tendency to assume a crystalline form.

ON THE

PRESENCE OF BARIUM AND STONTIUM IN A BOILER INCRUSTATION.

By C. L. BLOXAM.

A VERY hard crust removed from a kitchen boiler was found to contain, in addition to the calcium carbonate, sulphate, and silicate usually found in these deposits, a notable proportion of barium and strontium sulphates. The barium sulphate obtained from 100 grains of the incrustation was not worth weighing, but the strontium sulphate weighed 1·54 grains, representing 0·73 per cent of strontium.

The water from which the deposit was formed was derived from a deep well in the chalk at Harrow. It was remarkably bright and clear, and contained (grains per gallon) 14·48 SO_3, 8·88 Cl, 7·21 CaO (including the BaO and SrO), 5·61 MgO, 15·20 Na_2O (including a little K_2O and Li_2O), 12·60 CO_2 (combined), 1·28 SiO_2.

As the demand for strontia is increasing, through the introduction of the new process of extracting sugar, it is desirable that chemists should be on the look-out for it. In order to determine the strontium, the crust was treated with HCl, evaporated to dryness, the residue extracted with water, which left SiO_2, $CaSO_4$, $BaSO_4$, $SrSO_4$, sand and clay undissolved.

This residue was digested for two or three hours with a strong solution of Na_2CO_3, which dissolved the SiO_2 and converted the sulphates into carbonates. These were dissolved in HCl, filtered from the sand and clay, the solution neutralised with NH_3, acidified with $HC_2H_3O_2$, and mixed with $K_2Cr_2O_7$, which caused a slight precipitate of $BaCrO_4$. After twelve hours standing this was filtered off, and the diluted filtrate precipitated with H_2SO_4. After filtering off the $SrSO_4$, no further deposit occurred in the filtrate for many hours, after which the $CaSO_4$ began to crystallise.

The $SrSO_4$ was identified by digesting in Na_2CO_3, dissolving the $SrCO_3$ in HCl, and gently evaporating, when the long needles of strontium chloride were obtained. Both the barium and strontium precipitates were verified by the spectroscope.

The qualitative analysis of the crust was performed upon 1000 grains, from which a crop of crystals, over an inch length, of strontium chloride was obtained.

King's College, London,
December 27, 1883.

THE ESTIMATION OF CHLORINE, BROMINE, AND IODINE IN PRESENCE OF ONE ANOTHER.

By F. MAXWELL-LYTE.

IN the CHEMICAL NEWS (vol. xlviii., p. 284) is a paper by Paul Julius on the "Decomposition of Silver Chloride by Bromine, and of Silver Bromide by Iodine." Doubtless these experiments were made by him with a view to the separation of chlorine, bromine, and iodine from one another. In this connection the following will be found a convenient method :—

The haloids having been precipitated together with silver, the precipitate is to be collected, dried, and weighed.

It is now dissolved in about thirty or forty times its weight of water by the addition of the least possible quantity of cyanide of potassium. A quantity of pure bromide of potassium is now added, which need not be above the weight of the precipitate. The cyanide is now decomposed by the addition of an excess of dilute sulphuric acid.

The precipitate, in which any silver chloride has become by this means converted into silver bromide, is now collected on a filter, dried, and weighed.

It is once more dissolved by the least possible quantity of potassium cyanide, and the same quantity of water, and to this is now added one and a quarter times the original weight of the precipitate of potassium iodide.

The cyanide is now again decomposed by dilute sulphuric acid, and the precipitate once more collected on a filter, dried, and weighed.

In this last precipitate all the silver is converted into iodide, excepting such as was iodide already. In the second experiment all became bromide, excepting such as was bromide or iodide already.

From the weights then obtained from the first, second, and third weighings the chlorine, bromine, and iodine may easily be calculated. I use this plan, dissolving in cyanide, as I find sometimes that the addition of a soluble iodide or bromide may not suffice to decompose completely the bromide or iodide respectively. The cyanide used may be the ordinary commercial cyanide, *providing always*, as is usually the case, it be free from any trace of iodide.

Cotford, Oakhill Rd., Putney, SW.,
December 26, 1883.

SOME SPECIFIC GRAVITY DETERMINATIONS

By F. W. CLARKE.

THE following specific gravity determinations were made under my supervision by the students named below. The salts were weighed in benzene, and the density of water at 4 degrees was taken as unity. Each figure is the mean of several closely concordant results.

Uranyl sulphate, $(UO_2)SO_4.3H_2O$, 3·280 at 16·5°. H. Schmidt.
Uranyl ammonium sulphate, $(UO_2)Am_2(SO_4)_2.2H_2O$, 3·0131 at 21·5°. H. Schmidt.
Uranyl potassium sulphate $(UO_2)K_2(SO_4)_2.2H_2O$, 3·363 at 19·1°. H. Schmidt.
Double salt, $K_2CrO_4.2Hg(CN)_2$, 3·564 at 21·8°. H. Schmidt.
Ferric chloride sublimed, Fe_2Cl_6, 2·804 at 10·8°. J. P. Grabfield.
Ferrous chloride, $FeCl_2$, 2·988 at 17·9°. J. P. Grabfield.
Chromic chloride, violet, Cr_2Cl_6, 2·757 at 15°. J. P. Crabfield.
Chromous chloride, $CrCl_2$, 2·751 at 14°. J. P. Grabfield.

The last compound contained 14 per cent of chromic oxide as an impurity, and the sp. gr. actually found was 3·067. This, corrected by means of Schröder's value for Cr_2O_3, 5·01, gives the sp. gr. assigned above.

Strontium chloride, cryst., $SrCl_2.6H_2O$, 1·964, 16·7°. E. Muehlberg.
Cadmium chloride, $CdCl_2$, 3·655, 16·9°. P. A. Knight.
Cadmium bromide, $CdBr_2$, 4·794, 19·9°. P. A. Knight.
Cadmium fluoride, CdF_2, 5·994, 22·0°. E. A. Kebler.
Thallium iodide, precipitated, TlI, 7·072, 15·5°. E. Twitchell.
Thallium iodide, after fusion, TlI, 7·0975, 14·7°. E. Twitchell.
Thallium bromide, precipitated, TlBr, 7·540, 21·7°. H. Keck.
Thallium bromide, after fusion, TlBr, 7·557, 17·3°. H. Keck.
Lead bromide, precipitated, $PbBr_2$, 6·572, 19·2°. H. Keck.
Silver tartrantimonite, $SbAgC_4H_4O_7$, 3·4805, 18·2°. C. S. Evans.

—*American Chemical Journal*, vol. v., No. 4.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MAGNESIUM.

THERE is perhaps no common metal of which the atomic weight has been subjected to closer scrutiny than that of magnesium. The value is low, and its determination should, therefore, be relatively free from many of the ordinary sources of error; it is extensively applied in chemical analysis, and ought consequently to be accurately ascertained. Strange discrepancies, however, exist between the results obtained by different investigators; so that the generally accepted figure cannot be regarded as absolutely free from doubt.

The determinations of Berzelius† and other early chemists need not be here considered. Nor does the estimation made by Macdonnell‡ deserve more than a passing mention. He puts the atomic weight of magnesium at 23·9, but gives no details concerning his method of determination. The researches which we have to consider are those of Scheerer, Svanberg and Nordenfeldt, Jacquelain, Bahr, Marchand and Scheerer, and Dumas.

Scheerer's method of investigation was exceedingly simple.‖ He merely estimated the sulphuric acid in anhydrous magnesium sulphate, employing the usual process of precipitation as barium sulphate. He gives no weighings, but reports the percentages of SO_3 thus found. In his calculations, O = 100, SO_3 = 500·75, and BaO = 955·29. It is easy, therefore, to re-calculate the figures which he gives, so as to establish what his method really represents, viz., the ratio between the sulphates of barium and magnesium.

Thus revised, his four analyses show that 100 parts of $MgSO_4$ yield the following quantities of $BaSO_4$:—

	Per cent SO_3.
193·575	66·573
193·677	66·608
193·767	66·639
193·631	66·592

Mean 193·6625 ± 0·0274

Hence, using the atomic weights deduced in previous chapters for Ba, S, and O, Mg = 24·544 ± 0·0311. In a subsequent note§ Scheerer shows that the barium sulphate of the foregoing experiments carried down with it magnesium salts in such quantity as to make the atomic weight of magnesium 0·39 too low. Corrected, Mg becomes = 24·545.

The work of Bahr, of Jacquelain, and in part that of Svanberg and Nordenfeldt, also relates to the composition of magnesium sulphate. Jacquelain's experiments were as follows.¶ Dry magnesium sulphate was prepared by mixing the ordinary hydrous salt to a paste with sulphuric acid, and calcining the mass in a platinum crucible over a spirit-lamp to constant weight and complete neutrality of reaction. This dry sulphate was weighed and intensely ignited three successive times. The weight of the residual MgO having been determined, it was moistened with sulphuric acid and re-calcined over a spirit-lamp, thus reproducing the original weight of $MgSO_4$. Jacquelain's weighings for these two experiments show that 100 parts of MgO correspond to the quantities of $MgSO_4$ given in the last column:—

1·466 grm. $MgSO_4$ gave	0·492 grm. MgO.	297·968
0·492 „ MgO	„ 1·466 „ $MgSO_4$.	297·968

Jacquelain also made one estimation of sulphuric acid in the foregoing sulphate as $BaSO_4$. His result (1·464 grm. $MgSO_4$ = 2·838 grms. $BaSO_4$) reduced to the standard adopted in dealing with Scheerer's experiments, give for 100 parts of $MgSO_4$, 193·852 $BaSO_4$. If this figure be given equal weight with a single experiment in Scheerer's series, and combined with the latter, the mean will be 193·700 ± 0·0331. From this the atomic weight of magnesium becomes 24·244 ± 0·033. This again, corrected according to Scheerer for the magnesium salts carried down by the barium sulphate, becomes 0·39 higher, or Mg = 24·283. Of course this correction, determined by Scheerer for a single experiment, can only be a rough approximation in a mean like the foregoing. It is better than no correction at all, the character of the error involved being known.

Bahr's* work resembles in part that of Jacquelain. This chemist converted pure magnesium oxide into sulphate, and from the increase in weight determined the composition of the latter salt. From his weighings 100 parts of MgO equal the amounts of $MgSO_4$ given in the third column:—

1·6938 MgO gave	5·0157 grms. $MgSO_4$.	296·122
2·0459 „	6·0648 „	296·437
1·0784 „	3·1925 „	296·040

Mean 296·200 ± 0·0815

About four years previous to the investigations of Bahr the paper of Svanberg and Nordenfeldt† appeared. These chemists started with the oxalate of magnesium, which was dried at a temperature of from 100 to 105° until it no longer lost weight. The salt then contained two molecules of water, and upon strong ignition it left a residue of MgO. The percentage of MgO in the oxalate comes out as follows:—

7·2634 grms. oxalate gave	1·9872 oxide.	27·359	per cent.
6·3795 „	1·7464 „	27·359	„
6·3653 „	1·7418 „	27·364	„
6·2216 „	1·7027 „	27·368	„

Mean 27·3665 ± 0·0023

In three of these experiments the MgO was treated with H_2SO_4, and converted, as by Jacquelain and by Bahr in their later researches, into $MgSO_4$. 100 parts of MgO gave of $MgSO_4$ as follows:—

1·9872 grm. MgO gave	5·8995 $MgSO_4$.	296·875
1·7464 „	5·1783 „	296·513
1·7418 „	5·1666 „	296·624

Mean 296·671 ± 0·072

We have now for this ratio between MgO and $MgSO_4$ three series; not at all concordant. We may combine them, assigning to each of Jacquelain's two results a weight corresponding to one of Bahr's:—

Jacquelain	297·968 ± 0·0999	
Bahr	296·200	0·0815
Svanberg and Nordenfeldt	296·671	0·072
General mean	296·806	0·0475

In 1850 the elaborate investigations of Marchand and Scheerer‡ appeared. These chemists undertook to determine the composition of some natural magnesites, and, by applying corrections for impurities, to deduce from their results the sought for atomic weight. The magnesite chosen for the investigation was, first, a yellow, transparent variety from Snarum; second, a white opaque mineral from the same locality; and, third, a very pure

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Lehrbuch*, 5 Aufl., Bd. 3, s. 1227.
‡ *British Association Report*. 1852, part 2, p. 36.
‖ *Poggend. Annal.*, 69, 535. 1846.
§ *Poggend. Annal.*, 70, 407.
¶ *Ann. d. Chem. et Phys.*, 3 serie, 32, 202.

* *Journ. f. Prakt. Chemie*, 56, 310. 1852.
† *Ibid.*, 45, 473. 1848.
‡ *Ibid.*, 50, 385.

quality from Frankenstein. In each case the impurities were carefully determined; but only a part of the details need be cited here. Silica was of course easily corrected for by simple subtraction from the sum of all of the constituents; but iron and calcium, when found, having been present in the mineral as carbonates, required the assignment to them of a portion of the carbonic acid. In the atomic weight determinations the mineral was first dried at 300°. The loss in weight upon ignition was then carbon dioxide. It was found, however, that even here a correction was necessary. Magnesite, upon drying at 300°, loses a trace of CO_2, and still retains a little water; on the other hand, a minute quantity of CO_2 remains even after ignition. The CO_2 expelled at 300° amounted in one experiment to 0·054 per cent; that retained after calcination to 0·055 per cent. Both errors tend in the same direction, and increase the apparent percentage of MgO in the magnesite. On the yellow mineral from Snarum the crude results are as follows, giving percentages of MgO, FeO, and CO_2 after eliminating silica :—

CO_2.	MgO.	FeO.
51·8958	47·3278	0·7764
51·8798	47·3393	0·7809
51·8734	47·3154	0·8112
51·8875	47·3372	0·7753

Mean 47·3299 ± 0·0037

After applying corrections for loss and retention of CO_2 as previously indicated, the mean results of the foregoing series become—

CO_2.	MgO.	FeO.
51·9931	47·2743	0·7860

The ratio between the MgO and the CO_2, after correcting for the iron, will be considered further on.

Of the white magnesite from Snarum but a single analysis was made, which, for present purposes, may be ignored. Concerning the Frankenstein mineral three series of analyses were executed. In the first series the following results were obtained :—

8·996	grms. CO_2 =	8·2245	grms. MgO.	47·760	pr. ct. MgO.
7·960	,,	7·2775	,,	47·761	,,
9·3265	,,	8·529	,,	47·767	,,
7·553	,,	6·9095	,,	47·775	,,

Mean 47·766 ± 0·0022

This mean, corrected for loss of CO_2 in drying, becomes 47·681. I give series second with corrections applied :—

6·8195	$MgCO_3$ gave	3·2500	grms. MgO.	47·658 per cent.
11·3061	,,	5·3849	,,	47·628 ,,
9·7375	,,	4·635	,,	47·599 ,,
12·3887	,,	5·9033	,,	47·650 ,,
32·4148	,,	15·453	,,	47·674 ,,
38·8912	,,	18·5366	,,	47·663 ,,
26·5223	,,	12·6445	,,	47·675 ,,

Mean 47·650 ± 0·0069

The third series was made upon very pure material, so that the corrections, although applied, were less influential. The results were as follows :—

4·2913	$MgCO_3$ gave	2·0436	grms. MgO.	47·622
27·8286	,,	13·2539	,,	47·627
14·6192	,,	6·9692	,,	47·672
18·3085	,,	8·7237	,,	47·648

Mean 47·642 ± 0·0077

In a supplementary paper* by Scheerer, it was shown that an important correction to the foregoing data had been overlooked. Scheerer, re-examining the magnesites in question, discovered in them traces of lime, which had escaped notice in the original analyses. With this correction the two magnesites in question exhibit the following mean composition :—

	Snarum.	Frankenstein.
CO_2	52·131	52·338
MgO	46·663	47·437
CaO	0·430	0·225
FeO	0·776	—
	100·000	100·000

Correcting for lime and iron, by assigning each its share of CO_2, the Snarum magnesite gives as the true percentage of magnesia in pure magnesium carbonate the figure 47·624. To this, without serious mistake, we may assign the weight indicated by the probable error, ± 0·0037; the quantity previously deduced from the percentages of MgO given in the uncorrected analyses.

From the Frankenstein mineral, similarly corrected, the final mean percentage of MgO in $MgCO_3$ becomes 47·628. This, however, represents three series of analyses, whose combined probable errors may be properly assigned to it. The combination is as follows :—

± 0·0022
0·0069
0·0077

Result ± 0·0020, probable error of the general mean.

We may now combine the results obtained from both magnesites :—

Snarum mineral ..	Per cent MgO,	47·624	± 0·0037
Frankenstein mineral	,,	47·628	0·0020
General mean	,,	47·627	± 0·0018

The last investigation upon the atomic weight of magnesium which we have to consider is that of Dumas.* Pure magnesium chloride was placed in a boat of platinum, and ignited in a stream of dry hydrochloric acid gas. The excess of the latter having been expelled by a current of dry carbon dioxide, the platinum boat, still warm, was placed in a closed vessel and weighed therein. After weighing, the chloride was dissolved and titrated in the usual manner with a solution containing a known quantity of pure silver. The weighings which Dumas's reports give, as proportional to 100 parts of silver, the quantities of $MgCl_2$ stated in the third column :—

2·203	grms. $MgCl_2$ =	4·964	grms. Ag.	44·380
2·5215	,,	5·678	,,	44·408
2·363	,,	5·325	,,	44·376
3·994	,,	9·012	,,	44·319
2·578	,,	5·834	,,	44·189
2·872	,,	6·502	,,	44·171
2·080	,,	4·710	,,	44·161
2·214	,,	5·002	,,	44·262
2·086	,,	4·722	,,	44·176
1·688	,,	3·823	,,	44·154
1·342	,,	3·031	,,	44·276

Mean 44·261 ± 0·020

There are now before us the following ratios, from which to deduce the sought-for atomic weight :—

(1.)	$MgSO_4$: $BaSO_4$ :: 100 : 193·700	±	0·0331
(2.)	MgO : $MgSO_4$ :: 100 : 296·806		0·0475
(3.)	Per cent of MgO in oxalate, 27·3665		0·0023
(4.)	Per cent of MgO in carbonate, 47·627		0·0018
(5.)	Ag : $MgCl_2$ :: 100 : 44·261		0·020

From these we find three values for the molecular weight of MgO :—

From (2)	MgO =	40·587	± 0·0126
From (3)	,,	40·603	0·0069
From (4)	,,	39·922	0·0030
General mean	,,	40·054	0·0027

* *Ann. d. Chem. und Pharm.*, 110, 240.

* *Ann. Chem. Pharm.*, 113, 33. 1860.

We have also three values for the atomic weight of magnesium:—

From molecular weight of MgO ..	Mg = 24·091	± 0·0044
From ratio (1), corrected	„ = 24·283	0·033
From ratio (5), Dumas	„ = 24·576	0·032
General mean	„ = 24·103	0·0043

Or, if O = 16, Mg becomes = 24·159.

In this general mean all the determinations are included, good or bad. Dumas's result is unquestionably wrong; the error, probably, being due to the presence of oxychloride in the $MgCl_2$ which was used. It is doubtful whether any precautions could have eliminated that error. If we take only Marchand and Scheerer's work on magnesium carbonate as having positive value, we shall get from their analyses the following result, viz.: Mg = 23·959, ∓ 0·0046. Or, if O = 16, this becomes 24·014. The atomic weight of magnesium, therefore, varies from the whole number 24, only within the ordinary limits of experimental error.

The following additional note has been communicated by the author:—The atomic weight of this metal has very recently been revised by Marignac. Ten syntheses of $MgSO_4$ from MgO gave in mean Mg = 24·38. Twelve determinations made by calcining $MgSO_4$ and weighing the residual oxide gave Mg = 24·37. In his calculations Marignac uses Stas's value for S, and puts O = 16. (*Arch. des Sci. Phys. et Nat.* (3), 10, 206).—F. W. C.

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Continued from p. 301).

*Thermometers with a Limited Scale.**

Thermometers of this kind have been frequently used within the last few years to meet the difficulty of heating the entire mercury column, and it is generally recognised that it is inexpedient in ordinary experiments to attempt to make a correction for the portion of the scale which cannot be heated. Thermometers with a short scale have a reservoir blown in the glass about 1 c.m. above the bulb in order to contain the mercury corresponding to the number of degrees that it is intended to suppress. The total length of the useful part of the scale is about 15 c.m., but it is advisable to prolong the stem some 15 c.m. more for the convenience of fixing the thermometers in a boiling apparatus.

This mode of construction has some disadvantages which it is most important to remedy, since thermometers of this kind are the only ones which should be applied in accurate work at high temperature.

1. The rise of the zero-point is particularly hurtful because the mercury at zero eventually stands in the reservoir and the verification of the zero-point becomes impossible. These thermometers should always be subjected to the preliminary treatment which has been described in order to prevent the rise of the zero-point.

2. The determination of the fixed points which limit the scale of these thermometers (for example, the points 200° and 300°) has hitherto been made by methods far less accurate than those which are used for determining the points zero and 100°. If the constructor has determined these points by comparison with a standard thermometer in an oil-bath, errors of 5° are not uncommon, and much larger ones have been noticed. The only expedient which suffices to give results which can be compared with those obtained by observing the boiling-point of water and the melting-point of ice, consists in using a similar method for high temperatures. I have not succeeded in finding any melting-points constant enough for this use, but the boiling-points of several pure substances can be employed like that of water. Geissler introduced several years ago the use of naphthalene* for this purpose, and this step is a most important improvement; but he does not appear to have determined the boiling-point of naphthalene with an air thermometer, and the temperature which he gives is about 1° too low.

After having examined a great number of substances boiling between 150° and 360° I have only found two that unite all the qualifications which fit them for this use; they are naphthalene and benzophenone.†

It is not necessary that these bodies should be absolutely pure, provided the impurities do not affect the boiling-point, and some criterion can be established to mark the requisite degree of purification. It was found that the boiling-point of commercial naphthalene did not vary more than 0·10° when it had been purified by any method (chemical or physical fractional distillation or crystallisation) until the melting-point was brought to 79·9°—79·6°.

The same is true of benzophenone prepared by means of oxychloride of carbon, when it is purified until its melting-point is at 48·0° to 47·7°. It will be seen that considerable limits can be tolerated in the melting-points without an equal change in the temperature of the boiling-point: in other words, the common impurities cause the melting-point to vary, while they have nearly the same boiling-point. This quality was regarded as indispensable for the use in view, and it was found necessary to reject diphenyl-methane and other substances because they do not fulfil this condition. Bodies like essence of turpentine, which are capable of isomeric changes on heating, alcohols which absorb or give off water, ethers which are decomposed by moisture, as well as most acids, chlorides, and similar bodies, are unfitted for the purpose. A primary

* Thermometers of this kind made at Paris give the zero-point and temperatures commencing with about 10°, 20°, 100°, 150°, and so forth. In Germany, thermometers are much used which have the bulb only partially filled and whose scale runs from 98° to 360°.

* Dr. Geissler was kind enough to send me some of the naphthalene which he was in the habit of using, and I found it quite pure. The lower boiling-point which he has given is not necessarily in error, if the determination was made with a soda glass thermometer, because such an instrument might really give at 218° about 0·5° lower than the air thermometer, and an imperfection in the boiling apparatus used would easily account for the remainder. Geissler's thermometers do actually mark about 1° too low at this temperature.

† A mode of preparation of benzophenone, which was given by Friedel, Crafts, and Ador (*Comptes Rendus*, lxxxv., 672), renders the preparation of this substance possible on a large scale and with the necessity purity. The details of the process will be given elsewhere, but it may be well to indicate one or two points which show that it can be applied without difficulty in a manufactory of chemical products. Oxychloride of carbon is made to act upon benzene in the presence of chloride of aluminium. No difficulty is found in regulating the supply of carbonic oxide when the gas is passed first into a large floating gas-holder containing 50 litres; very simple means suffice to mix in equal volumes chlorine and carbonic oxide, and if the mixture is well made there is scarcely a limit to the rapidity with which it may be passed through a large apparatus in bright sunlight. Three glass balloons of 10 m.m. capacity each were used, and the combination takes place chiefly in the first with a considerable evolution of heat. In diffused light the current of the two glasses must be relatively slow. When carbonic oxide has been used in slight excess the product frequently contains no free chlorine, and in any case an excess of chlorine may be conveniently removed by passing the product into a fourth balloon containing a little benzene exposed to the sunlight. Under the circumstances this absorbent for chlorine is more convenient than zinc or antimony; the rate of formation of oxychloride of carbon can be estimated by condensing it in benzene cooled first with ice and then with a freezing mixture. 100 grms. an hour can be obtained with great regularity, and the chloride of aluminium can be subsequently added to this mixture, or the oxy-chloride of carbon can be passed directly into benzene to which 25 per cent chloride of aluminium has been added. When the benzene used has been purified by distillation or by fractional crystallisation until its melting-point is above 4·5°, the crude benzophenone contained in the reaction is almost pure. It varies only about half degree in its boiling-point, and the subsequent complete purification is easy.

requisite for this purpose is stability on heating. That of naphthalene is well known, and the inalterability of benzophenone, when boiled for ten days even under pressure, was tested with perfectly satisfactory results. The vapour-density of benzophenone is normal even at a red heat.

The boiling-points of pure naphthalene and benzophenone were determined with great care by means of the hydrogen thermometer under pressures varying from 85 m.m. to 1800 m.m. and a formula found representing their vapour tension. These results, which will be described elsewhere, give the means for heating at will to any fixed temperature between 100° and 360°.

It will be sufficient for our present purpose to give in the following table the boiling-points of these two substances under the ordinary atmospheric pressures.

Vapour Tensions.

Naphthalene.		Benzophenone.	
Temperature.	Millimetres.	Temperature.	Millimetres.
215·7	720·39	303·7	723·95
215·8	722·05	303·8	724·77
215·9	723·69	303·9	726·29
216·0	725·34	304·0	727·80
216·1	727·00	304·1	729·33
216·2	728·65	304·2	730·86
216·3	730·31	304·3	732·38
216·4	731·98	304·4	733·92
216·5	733·65	304·5	735·45
216·6	735·32	304·6	736·98
216·7	736·99	394·7	738·52
216·8	738·67	304·8	740·06
216·9	740·35	304·9	741·60
217·0	742·03	305·0	743·14
217·1	743·72	305·1	744·69
217·2	745·41	305·2	746·24
217·3	747·10	305·3	747·79
217·4	748·80	305·4	749·36
217·5	750·50	305·5	750·91
217·6	752·20	305·6	752·47
217·8	753·90	305·7	754·03
217·9	755·31	305·8	755·60
218·0	759·02	305·9	757 17
218·1	760·74	306·0	758·74
218·2	762·46	306·1	760·32
218·3	764·18	306·2	761·90
218·4	765·91	306·3	763·48
218·5	767·63	306·4	765·06

Apparatus for Vapour Tensions.

Under the atmospheric pressure the above substances can be used for fixing the scales of thermometers or for correcting them in any kind of glass apparatus, and when a thermometer is to be used for ordinary distillations the corrections can be most conveniently made by boiling in the same vessel some substance of known boiling-point falling nearly at the same temperature; and if the scale cannot be entirely heated, the same number of degrees may be left outside in the two cases to be compared. With proper precautions a series of corrections can be thus established with an error of less than 0·5°; but the temperatures that are read off on the thermometers under these circumstances are not usually the true ones, and the corrections must be based upon the known boiling-points of the standard substances, which have been determined with special care. Some directions regarding the use of corrected thermometers with a limited scale are given further on under the heading Distillation, but a greater accuracy has been aimed at with the standard apparatus destined for the manufacture or the exact correction of thermometers. The chief difficulty is to avoid superheating the lower strata of vapour, when a column high enough to envelop the scale of the thermometer is heated. If, for instance, benzophenone is boiled in a large glass vessel, with a neck at least 5 c.m. wide, it requires a very powerful heat to maintain a column of vapour 30 to 40 c.m. high, and an ordinary long thermometer is found to vary 2 to 3 tenths of a degree according as it is raised or lowered a few centimetres in the vapour.

Considerably better results are obtained by surrounding the neck of the flask with a non-conducting jacket of plaster or mineral wool, and following in the direction thus indicated, various forms of metallic apparatus were constructed, in which a sensitive thermometer with a short scale showed the same temperature to within less than one-tenth degree when placed at any height above the boiling liquid.

Figures 1 and 2 represent a copper apparatus specially adapted to the graduation of thermometers. The metal is 2 m.m. thick and will bear a pressure of two atmospheres. All the parts are brazed. The space between the true apparatus B and an outer cylinder A made of stove-pipe is 3½ c.m. It is filled with mineral wool to prevent radiation. B is 8 c.m. largest diameter and 47½ long. The section Fig. 1 shows its elliptical form, and the smaller diameter is 5½ c.m. C represents an inner tube of thin copper intended to protect the vapours from condensation. It is pierced with holes as shown by the dotted portions near the bottom and the top. The vapours rise principally between this tube and D, and the condensed liquid runs down the sides of B. D represents a flattened tube, 3 c.m. by ½ c.m. in section, and 43 c.m. long. It contains five or six thermometers, which can be conveniently observed together by means of a telescope. When the thermometers are nearly of the same size they may all be held at the requisite height by the slight pressure of a single spring clamp, or they may be grasped by a series of watch-spring clamps, or simply suspended from threads. An easy adjustment of the height is important. The vapours are condensed in the tube E, and the condenser is of a peculiar form to prevent the stoppage of the tube by the solidification of crystalline substances. Water is allowed to flow constantly into *g*, and out drop by drop at *g'*, and the water consequently remains always at the level of *g'* in the condenser. The water is soon heated to boiling, the steam escapes at *h*, and the vapours of naphthalene and other substances are condensed at 100° instead of at the ordinary temperature, and flow back as liquids. In an ordinary operation it is not even necessary to renew the water, and it is only when the heating is long-continued that a flow of water becomes necessary. For substances which like benzoic acid melt higher than 100°, the water may be replaced by amylic alcohol or by some other convenient liquid, and a lead tube (not shown in the figure) soldered upon *h* can be so arranged as to return the amylic vapours in the form of liquid to the condenser at *g*.

The apparatus of Figs. 1 and 2 is long enough to heat any ordinary thermometer, but when a great sub division of the scale makes it of unusual length, the protruding portion of the stem is heated to the same temperature by the cylinder (Fig. 3), which is put upon the top of the first, and contains the same standard substance. The non-conducting jacket is so arranged as to allow the flame to play around B, and this part of the cylinder projects enough to allow a lamp to be placed under it. Any number of such cylinders may be superposed, so that there is no limit to the length of a thermometer which may be heated to a fixed temperature without danger of superheating the vapours.

Several questions regarding the accuracy of this method of fixing temperatures required to be studied experimentally.

The temperature was found to be exactly the same whether the interior tube D was used as an air-bath or was filled with high-boiling paraffin, and the use of oil or paraffin was rejected because it has many inconveniences. The tube D can be made cylindrical and of much larger dimensions to fit it for air thermometer work, without making any difference in the temperature, when the mouth is well stopped with asbestos.

It was thought possible that the condensed liquid from

E flowing back along the sides of D might lower the temperature, and comparative experiments were made with the apparatus described and with that represented on a smaller scale (Fig. 4), in which the vapours are so condensed as to be returned by the small tube E to the bottom of the apparatus. The results were identical in each case.

Other experiments were made by enlarging the bottom of the cylinder and by varying the quantity of the liquid, and it was found that such variations made no difference in the temperature, provided radiation of heat was well guarded against. The simplest form, Figs. 1 and 2, was therefore chosen, and it is believed that it is well adapted to obtaining the true boiling-point of a high-boiling substance, as Rudberg's (Regnault's) apparatus is to measuring the boiling-point of water.

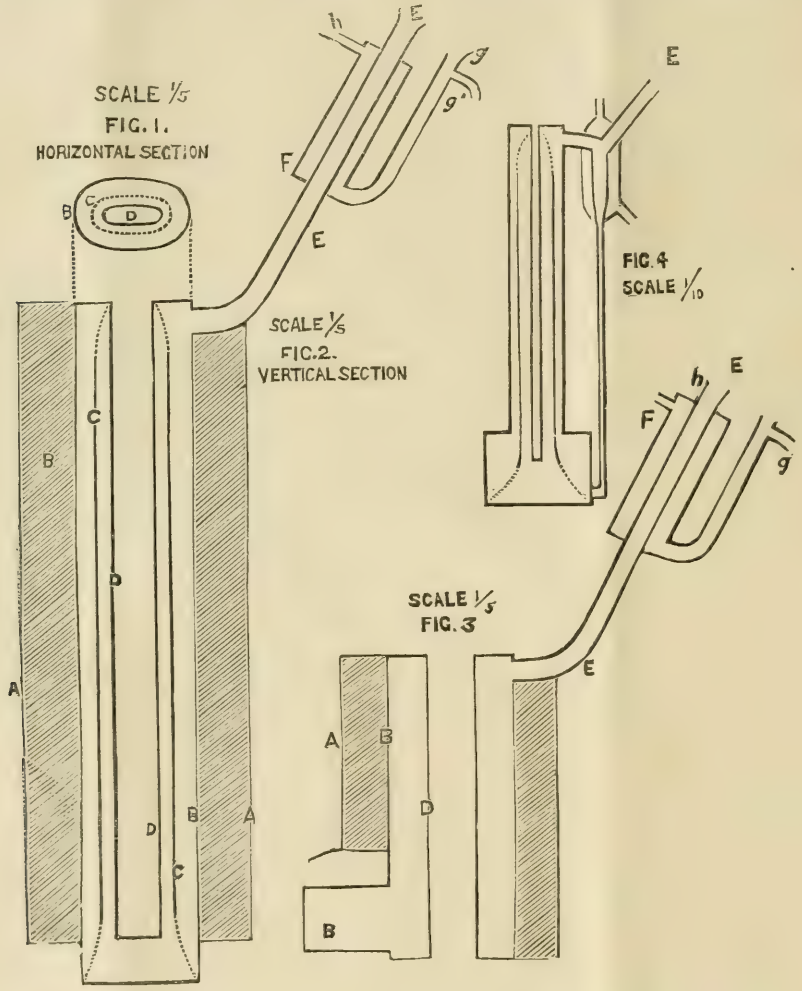
A smaller apparatus, in which the interior tube D is cylindrical and only 5 m.m. in diameter, is used for examining a single thermometer, and it can be used more quickly since it requires only six to eight minutes for the temperature to become stationary. With the larger apparatus a longer time is required, and the error which is most likely to occur on working with it arises from not waiting patiently until the mercury column has become stationary.

The thermometers are plunged in the tube D so that at the moment of reading only about 1° appears above the top. This requires a certain adjustment, which can be made after they have been heated about ten minutes; and since this operation may bring cool parts of the stem in contact with the tube D, and change the temperature of the air-bath, eight to ten minutes must usually elapse after the final adjustment before the temperature becomes constant and before the final reading should take place. For this cause there is even a certain advantage in replacing the single tube D by a number of smaller ones, each containing a single thermometer.

The liquid must be made to boil constantly, so that the condenser is heated with about equal rapidity in all determinations, a point which there is no difficulty in appreciating.

All these forms of apparatus can easily be connected at E with a reservoir of about 20 litres capacity, filled with air at any pressure, and no difficulty was found in boiling naphthalene and benzophenone under pressures varying from 100 to 1500 m.m., so that any temperature within the ordinary thermometric scale can be determined, and the apparatus can thus be used for correcting or for graduating the whole scale.

The examination of different points in the scale of a thermometer by means of such an apparatus may replace advantageously all the corrections arising from errors of graduation, calibration, and the departure from the air thermometer scale. The operation is more accurate and



infinitely less tedious than the usual ones for temperatures higher than 100°.

(To be continued.)

CORRESPONDENCE.

VOLUMETRIC ESTIMATION OF MANGANESE.

To the Editor of the Chemical News.

Sir,—I beg to call Mr. Stone's attention to a method of estimating the manganese in spiegels, more rapid than, and about as accurate as, those he refers to in the Chemical News, vol. xlviii., p. 273.

It has been in use here for some time. The results obtained by it have been very frequently compared with those obtained by the usual gravimetric method, and we have found a remarkably close agreement: seldom 0·4 per cent difference, and more frequently 0·2 per cent or less.

It is a modification of the well-known indirect method of estimating the iron present, adding a certain constant number, 5 or 6 usually, and calling the rest manganese. I have found by estimating the silicon as well as the iron, and adding 5 per cent, that the remainder expresses the per cent of manganese present within the narrow limits just mentioned, and this seems to hold good for spiegels containing 8 to 30 per cent manganese. Beyond this I have as yet had no experience, and further modifications may be then required.

The method of operating is as follows:—Dissolve about 0·5 grm. of finely powdered spiegel in dilute H_2SO_4. When completely dissolved, dilute, and titrate with bichromate as usual. The silicon is quickly separated by dissolving 2 grms. of spiegel in slightly dilute HCl, using a wide beaker on a hot plate and evaporating to dryness; re-dissolve in HCl, filtering, washing, and igniting as usual.

There is nothing new in the method of analysis, but the estimation of the silicon in addition to the iron most certainly adds very much to the correctness of the results, and I have not heard of its being done as a regular thing before. Of course it is most advisable with a fresh series of spiegels from a new source to check these results by the gravimetric method in order to see whether the 5 per cent for carbon, &c., is sufficient allowance or too much; but half a dozen determinations ought to settle that point.

The method I have now proposed is, of course, not intended to supplant the gravimetric method, but to enable works' chemists to ascertain with rapidity and fair accuracy what the per cent of manganese actually is. I subjoin a few, from scores of similar results obtained in this laboratory, for comparison, one operator estimating the m.m., by Fe+Si+5 per cent, and another doing the same sample gravimetrically:—

Fe+Si+5 per cent. Manganese per cent.	Gravimetric. Manganese per cent.
27·79	28·10
24·48	24·63
22·88	23·04
20·61	20·30
18·80	18·70
13·18	13·24

—I am, &c.,

A. H. Holdich.

Wigan Coal and Iron Co.

VAPOUR-TENSIONS OF MERCURY.

To the Editor of the Chemical News.

Sir,—I have just read Prof. McLeod's paper on the pressure of mercury vapour (Chemical News, vol. xlviii., p. 251), and the question arises in my mind whether so heavy a vapour would saturate the whole interior of the flask, from so small a surface, in a few days or a month. The method might well be applied to studies in gaseous diffusion; for example, by connecting a series of Wolff bottles, and testing the contents of each after a certain interval.—I am, &c.,

Robt. B. Warder.

Lafayette, Ind., Dec. 17, 1883.

THE LATE MR. RICHARD TALLING.

To the Editor of the Chemical News.

Sir,—The recent death of Mr. Richard Talling deserves, I think, a passing notice in the pages of your journal. Although not a chemist, Mr. Talling possessed a wonderful knowledge of minerals, and it is not too much to say that the mineralogy of his own county, Cornwall, is largely indebted to him for the development of many new and most interesting specimens. In finding a mineral which he had not observed before, Mr. Talling immediately submitted it to those competent to undertake its analysis, and the *Journal of the Chemical Society* bears ample testimony to his zeal and perseverance, in the papers of Professors Maskelyne, Church, and others. Some fifteen months ago, Mr. Talling, at my request, sent me a list, of which the following is a copy, comprising the various minerals which he actually had discovered, as *new* to science or previously unknown to British mineralogy, which will give some idea of the extent of his labours. The list is entirely his own, and I am not responsible for any errors that may exist therein.

Minerals New to Science.

Name.	Determined by.
Andrewsite	Prof. Maskelyne
Bayldonite	Prof. Church
Botallackite	,,
Churchite (very rare)	,,
Chenevixite	Prof. Pisani
Develline	,,
Langite	Prof. Maskelyne
Ludlamite	Mr. Fred. Field
Tavistockite	Prof. Church
Tallingite	,,
Warringtonite	Prof. Maskelyne
Liskeardite	(?)

Minerals New to British Mineralogy.

Name.	Determined by
Bleinierite	Dr. Percy
Agalmatolite	Dr. Greg
Atacamite	Prof. Church
Marmatite	,,
Ehlite	,,
Eulytine (very scarce indeed)	(?)
Hisingerite	Prof. Church
Frankolite (new variety)	Prof. Maskelyne
Chalcosiderite	,,
Cronstedtite (new variety)	Mr. Fred. Field
Dufrenite (?)	,,

It must be allowed, I think, that some of the most splendid specimens in the magnificent collection of the British Museum have been obtained from Mr. Talling, and the principal museums throughout Europe and America are enriched and beautified by his contributions.

It would be well for mineralogy if there were more men amongst us with the energy and sagacity of the late Mr. Talling. How many new and beautiful specimens might have been saved that have been heedlessly cast into the smelting furnace!—I am, &c.,

Frederick Field.

* This very interesting mineral, which I am persuaded is Dufrenite was under examination when illness compelled me to leave England. I did not care to publish my results until further experiments had corroborated my first determinations. I have a specimen in my collection.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 22, November 26, 1883.

Hydration of Crotonic Aldehyd.—Ad. Wurtz.—The author's experiments go to prove that aldol and its condensation products are formed by the hydration of crotonic aldehyd under the influence of water and of hydrochloric acid. He has not succeeded in isolating crotonic aldehyd.

A Magnetic Induction-Compass.—M. Mascart.—The author's apparatus comprises an azimuth circle upon which moves an arrangement carrying a ring movable on an horizontal axle; the angle which this ring makes with the horizon is measured by a vertical circle; the frame, only 0·12 metre in diameter, is supported by the ring, and can turn upon an axle perpendicular to that of the ring. The dimensions of the instrument are not greater than those of an inclination-compass.

Electric Synchronism of Two Relative Movements, and its Application to the Construction of a New Electric Compass.—Marcel Deprez.—This memoir does not admit of useful abstraction.

The Study of Telluric Currents.—E. E. Blavier.—It is concluded, contrary to the general opinion, that underground lines are not more influenced by terrestrial currents than are aërial lines. If such currents disturb transmission on the subterranean lines rather more, this is because their copper conductors offer less resistance. The telluric currents have evidently an intimate connection with the variations of the earth's magnetism. Whether they are the cause or the effect of these variations can only be decided by a comparison of the electric and the magnetic curves. An attentive study of the former will decide if the movements of the sun and moon have an inductive influence, as certain physicists think.

Force of Induction Produced at a Distance by any System whatever of Small Plane Electric Currents of Varying Intensity: Equivalent Spherical Selenoid.—M. Quet.—A mathematical paper, not capable of useful abridgment.

Measurement of the Difference of Potential of the Electric Strata which cover two Liquids in Contact.—E. Bichat and R. Blondlot.—This memoir requires the four accompanying diagrams.

Micro-thermometer for the Measurement of very small Variations of Temperature.—F. Larroque.—The author has constructed thermometers, by means of which he can estimate variations of temperature to $\frac{1}{10000}$ degree.

Studies on the Chemical Action of Light: Decomposition of Oxalic Acid by Ferric Chloride.—G. Lemoine.—This paper requires the accompanying diagrams.

Dissociation of Anhydrous Ammonium Carbonate in presence of an Excess of its Elements.—M. Isambert.—Experiment verifies the law established theoretically, admitting decomposition at the moment of evaporation, and these measurements confirm the fact of this decomposition, which the author has previously established by the compressibility of this vapour.

Fusibility of Salts, Nitrates.—E. Maumené.—Barium and strontium nitrates cannot be melted; but if they are placed in small crystals upon a mass of potassium or sodium nitrate they can be melted without any loss of oxygen or of nitrous acid. Barium nitrate with potassium nitrate in equal equivalents melts at 370°. A mixture of alkaline nitrates with ammonium nitrate melts at 122°, and may serve instead of an oil-bath.

Hydro-nicotine and Oxy-tri-nicotine.—A. Etard.—Hydro-nicotine, $C_{10}H_{16}N_2$, is an oily substance, of sp. gr. 0·993 at 17°, and boils at 263°. It is soluble in water, alcohol, and ether in all proportions. Oxy-tri-nicotine has the composition $C_{30}H_{27}N_6O_2$.

No. 23, December 3, 1883.

Absorption-Spectrum of the Blood in the Violet and Ultra-violet Part.—M. J. L. Soret.—The author has previously mentioned the absorption-band which diluted blood gives in the violet portion of the spectrum. With blood diluted to $\frac{1}{1000}$, and of the thickness of 10 m.m., this band occupies about the half of the interval comprised between G and H, its centre falling upon *h*; the ultra-violet is transmitted. With the blood at $\frac{1}{600}$ it fills the entire space between G and H, the region beyond H being darkened. With blood at $\frac{1}{400}$ it spreads beyond G and especially beyond H; all the ultra-violet is much darkened. If the blood has been treated with carbon monoxide this band is slightly driven back from the more refrangible side, and the ultra-violet is less darkened than with oxygenated blood of equal dilution.

Secular Variation of the Direction of the Terrestrial Magnetic Force at Paris.—M. L. Descroix.—The author gives his results in the form of tables.

Measurement of the Difference of Potential of the Electric Strata which cover two Liquids at Contact.—MM. E. Bichat and R. Blondlot.—An illustrated paper, not adapted for useful abstraction.

Researches on the Duration of the Solidification of Superfused Sulphur.—D. Gernez.—The variations which the author has observed in the solidification of prismatic sulphur depend evidently on the changes experienced by the specific heat of the liquid sulphur and the solidification heat of the prisms. Liquid sulphur is capable of undergoing, at a constant temperature, a modification which depends on the duration of action of the source of heat.

Formation-Heat of Certain Lead Oxychlorides and Oxybromides.—G. André.—The heat developed increases by about + 1 cal. for the addition of each equivalent of lead oxide.

Artificial Production of Spessartine or Manganiferous Garnet.—A. Gorgen.—The author treats a mixture of manganese chloride and of clay at a cherry-red heat with a current of hydrogen saturated with watery vapour.

Researches on Saccharogeny in the Beet.—Aimé Girard.—A lengthy account of the origin and accumulation of betose in the tissues of the beet-plant.

On Bi-primary Bichlorised Ethyl Acetate.—Louis Henry.—This compound is a colourless liquid, of a slightly pungent odour and a burning taste. Its spec. gr. at 10·6° is 1·3217, and it boils at 197°—198°. It is insoluble in water.

Conditions suitable for accelerating the Oxidation of Drying Oils.—Ach. Livache.—The author finds that manganese is the most effective desiccating agent.

Bulletin de la Société Chimique de Paris.
No. 8, November 5, 1883.

Explosive Wave.—MM. Berthelot and Vieille.—The researches of the authors reveal the existence of a new kind of undulatory movement of a mixed order, produced in virtue of a certain concordance of physical and chemical impulsions within a substance which is undergoing transformation. The characteristic of this order of phenomena is the production of an explosive wave, *i.e.*, of a regular surface in which the transformation is developed. This surface, when once produced, is propagated from layer to layer throughout the entire mass, in consequence of the transmission of the successive shocks of the gaseous

molecules, which are brought to a more intense vibratory state by the heat liberated in their combination. Such effects are comparable to those of a sound wave, but with this capital difference, that the latter is transmitted with a very inconsiderable *vis viva*, a very small excess of pressure, and a speed determined solely by the physical constitution of the vibrating medium.

Reactions between Sulphur, Carbon, their Oxides, and their Salts.—M. Berthelot.—If sulphurous acid is submitted to electrolysis in a sealed tube with platinum electrodes, the decomposition is arrested after a certain point. No free oxygen is formed, but a part of the sulphur combines with the platinum, the surplus forming with the sulphuric anhydride a viscous compound, which then absorbs a portion of the sulphurous gas. The decomposition of carbon monoxide under the influence of the spark, or of a red heat, is limited in extent. It begins long before white redness. The author further studies the mutual behaviour of sulphur and carbon in their various combinations.

Arrangement for the Use of the Penumbra Saccharimeter.—E. Allary.—Instead of being lighted by a lamp the polariser is enclosed in a cylinder of pasteboard, blackened within and pierced with a circular aperture, covered with a transparent yellow paper as nearly as possible approaching the shade of the spectral yellow. The observer then covers the entire apparatus and his own head with a black veil, and proceeds to the study of the solutions in question.

MEETINGS FOR THE WEEK

MONDAY, Jan. 7th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 8th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.
—— Royal Medical and Chirurgical, 8.30.
—— Institute of Civil Engineers, 8.
—— Photographic, 8.
WEDNESDAY, 9th.—Microscopical, 8.
—— Geological, 8.
THURSDAY, 10th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 11th.—Astronomical, 8.
—— Quekett Microscopical, 8.

ST. PAUL'S SCHOOL.—An EXAMINATION for filling up about six vacancies on the Foundation will be held on the 22nd January, 1884. For information apply to the Clerk to the Governors, Mercers' Hall, E.C.; or to the School Secretary, St. Paul's Church Yard, E.C.

ANALYTICAL AND CONSULTING CHEMIST.—Mr. H. S. CARPENTER, F.I.C., F.C.S., Member of the Society of Public Analysts, &c., performs Analyses of Commercial and Agricultural Samples, Minerals, &c.; also of articles of food and drink, drugs, poisons, gases, waters, &c. Scale of Fees forwarded on application.—The Metropolitan Laboratory, 32, Holborn Viaduct, E.C.

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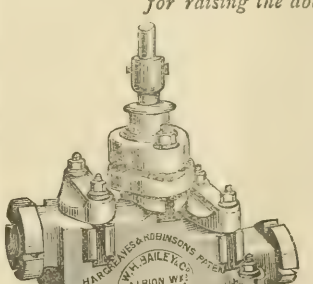

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1259.

ON THE TEMPERATURE OBTAINED BY OXYGEN IN EBULLITION, AND ON THE SOLIDIFICATION OF NITROGEN.

By M. S. WROBLEWSKI.

Of all the gases formerly considered as permanent, hydrogen is the only one which has failed to give, at a temperature of −136° C., any sign of liquefaction. Not even is there any cloud produced in the tube containing it if the gas at this temperature, compressed to 150 atmospheres, is suddenly released. To liquefy hydrogen we must evidently have recourse to a lower temperature than the lowest obtained by liquid ethylene allowed to boil in a vacuum. Among the gases which are more difficultly liquefiable than ethylene, and therefore suitable for the production of a much more intense cold, oxygen has appeared to me to be most easily available.

The conditions for the liquefaction of oxygen being well understood from the researches which I have had the honour to bring before the Academy, it follows that this gas can now be liquefied in considerable quantities with great ease. A thousand devices and kinds of apparatus may be imagined by which this liquefaction can be effected. Indeed, the industrial production of liquid oxygen is, I may almost say, only a question of the material means at the disposal of the experimentalist. Thus, I have employed, since the month of October last, liquid oxygen as a refrigerating agent, and I ask permission to lay before the Academy the results of my experiments.

Liquefied in large quantity, and suddenly allowed to evaporate by release of the pressure, oxygen does not solidify like carbonic acid, but it leaves a crystalline residue on the bottom of the apparatus in which it was kept in the liquid state and on the object to be cooled plunged in the oxygen. I am not able to say if this residue consists of crystals of oxygen only or if it is due to possible impurities, since the oxygen I used was prepared from a mixture of potassium chlorate and manganese peroxide. This residue disappears when the temperature begins to rise. If the body to be cooled is in a glass tube, the thin layer of this opaque residue is often very annoying for the observer.

Another circumstance which renders it very difficult to employ liquid oxygen as a refrigerating agent is the necessity of using it in closed vessels having great strength. I have not yet been able to obtain oxygen in the form of a static liquid at the normal atmospheric pressure. It has therefore been necessary to immerse the substances to be cooled in the apparatus which I fill with liquid oxygen, and I can only make use of the cold produced by the oxygen when boiling on the sudden release of the pressure. As these apparatus are partly constructed of glass great inconvenience is caused by the constant danger of serious explosions. After several accidents which have occurred during these experiments, my assistants and myself now always work with masks before our faces.

But the greatest difficulty in these experiments is the very short duration of the ebullition of liquid oxygen, and consequently the too short time of the refrigeration.

I have attempted to measure the temperature of oxygen when in a state of ebullition. For this purpose I have employed a thermo-electric method of measuring which, besides its great sensitiveness, admits of the registration of all the sudden changes of temperature of the medium. The indications of the apparatus have been compared with those of a hydrogen thermometer between +100° C. and −130° C. The nature of the function connecting these two indications permits an extrapolation being made.

Reserving the description of my method to a subsequent communication I may here give *one hundred and eighty-six degrees below zero* (−186° C.) as the first approximation to the temperature produced by the sudden release from pressure of liquefied oxygen.

I have submitted nitrogen successfully to the action of this cold. This gas compressed, cooled in boiling oxygen, and then allowed to expand a little, solidifies and falls like snow in crystals of remarkable size.—*Comptes Rendus*, Dec. 31, 1883.

ON THE FORMATION OF SULPHURIC ACID IN THE LEAD CHAMBERS.*

By Professor G. LUNGE.

1. In the ordinary course of working no hyponitric acid exists in the lead chambers. This acid takes no part in the formation of sulphuric acid. It arises merely as a secondary product and under quite peculiar circumstances.

2. In presence of a large excess of nitrous gases, the formation of N_2O_4 takes place in the last chamber, and in this there is very little sulphuric acid produced. It seems very probable that the absence or the reflux of sulphurous acid are of great importance for the production of N_2O_4.

3. The quantity of oxygen contained in the gas of the chambers has little influence on the formation of N_2O_4.

4. If the gaseous current in the chambers is yellow, the loss in N_2O_3 and N_2O_4 in the Gay-Lussac tower is of a certain importance, and under ordinary circumstances may rise to 60 per cent of the total loss.

5. If the gaseous current is colourless the loss in nitrate in the Gay-Lussac tower is equal to 0·5 per cent of nitre, or to 20 per cent of the entire loss. The gases which escape contain mere traces of N_2O_3 and N_2O_4, but, instead, NO and SO_2.

6. We never find N_2O_4 in the tower acid, even when the gases of the chambers and the escaping gases contain it.

7. During the transformation of SO_2 into H_2SO_4 there occurs an anomaly which is not without interest. As far as to the centre of the first chamber 75 per cent of the total quantity of sulphurous anhydride are transformed into sulphuric acid; from there to the end of the chamber only 4 per cent more of SO_2 are converted. The total quantity of SO_2 is further lessened by 10 per cent after the gases have traversed the connecting pipe between the first and the second chamber. The employment of a system of several chambers is very favourable to the good working of the plant, for in passing from one chamber to another the gases undergo a slight compression in the pipes, and are mixed in an intimate manner.

8. In the centre of the first chamber the mixture of gases is almost complete. The composition of the gaseous mixture is the same at different heights. At the centre there is from 0·1 to 0·2 per cent more SO_2 than along the sides.

9. It is improbable that the gases which penetrate into the chambers rise at first, and afterwards slowly redescend. They become quickly mixed already in the anterior portion of the first chamber.

10. The progress of the temperature in an entire system of chambers is very regular. In the first fourth part of the first chamber, where the chemical reactions are very intense, the temperature of the gases rises about 5° to 6°,

* A paper read before the Helvetic Society, based upon results obtained by M. Naef, of the Uetikon Works, under the author's direction.

and then falls slowly. Towards the end of the series of chambers the fall of temperature is a little stronger.

11. On increasing the cubic measurement of the chambers from 1·5 to 1·8 metres per 3 kilos. of sulphur burnt in the two first chambers, there is observed a decrease of temperature of from 9° to 10°, and in the third of 5° to 6°.

12. The reduction of temperature by the sides of the chambers is scarcely perceptible in the interior beyond the distance of 25 centimetres from the side, the ambient temperature being 19°. At 5 to 10 centimetres from the side the reduction of temperature is 2°, and at 10 to 25 centimetres only 1°. From the distance of 25 centimetres from the wall to the middle of the chamber the difference of temperature is 5°, and from the side to the centre 8°.

13. In the middle of the first chamber the temperature is lower by 5° at the bottom than at the top.

14. The use of the pulverised water instead of steam has no great influence upon the temperature of the chambers.—*Moniteur Scientifique Quesneville.*

ON THE VOLUMETRIC DETERMINATION OF MERCURY.

By GUSTAV KROUPA.

If recently precipitated mercurous chloride is covered with sulphuretted hydrogen water, the mercurous chloride is at once transformed into sulphide and hydrochloric acid. If the excess of hydrogen sulphide is removed in a suitable manner, and the quantity of chlorine in the solution determined, the proportion of mercury may be readily calculated. The author proceeds in the analysis as follows .—If the mercury is present in the mercurous state it is precipitated at once with sodium chloride. If it exists in the mercuric state and no hydrochloric acid is present, a sufficiency of sodium chloride is added, and then a solution of ferrous sulphate and an excess of potassa. The mixture is allowed to stand for a few minutes in the cold, and is diligently stirred with a glass rod. The precipitate of mercurous oxide and ferroso-ferric oxide is strongly acidified with dilute sulphuric acid and stirred till the black precipitate has become a pure white, the formation of mercurous chloride being complete. This is filtered off, washed well, placed along with the filter in a beaker, covered with sulphuretted hydrogen water, and allowed to stand for a few minutes. The hydrochloric acid formed is neutralised by the addition of an excess of elutriated barium carbonate, whilst the excess of hydrogen sulphide is removed by a solution of zinc acetate, which at the last is added in drops until no more odour of hydrogen sulphide is perceptible. The precipitate is filtered again, and, after washing, the filtrate is mixed with an excess of potassium chromate and titrated with silver solution in such a manner that at first a small excess of silver is run in, which is removed by means of a measured quantity of an equivalent solution of sodium chloride and the operation finally completed with a centinormal silver solution.—*Chemiker Zeitung* and *Oesterr. Zeitschrift Berg. und Hütten.*

DETERMINATION OF IODINE IN A MIXTURE OF IODIDES, BROMIDES, AND CHLORIDES.

By A. CAVAZZI.

From a mixture of chlorides and iodides the iodine can be isolated by a boiling solution of neutral ferric chloride, but if bromides are present bromine also is liberated. In order to remove the iodine alone from a mixture of the three kinds of haloid compounds, the author uses ferric sulphate instead of the corresponding chloride. It must be previously heated almost to redness in order to make it perfectly free from acid. As the calcined salt dissolves with difficulty in water a little ferrous sulphate is added, which increases the solubility and renders the solution permanent. Two grms. ferric sulphate, in presence of 0·1 to 0·2 grm. ferrous sulphate, dissolve readily in 25 c.c. of boiling water. If a mixture of chloride, bromide, and iodide is boiled with this solution the iodine alone is separated out. The author absorbs the iodine in potassa, reduces the iodate to iodide by means of hydrogen, which is evolved in the alkaline solution by aluminium, and precipitates the iodine with silver nitrate.—*Chemiker Zeitung.*

PARATOLUIDINE SULPHATE AS A REAGENT FOR NITRIC ACID.

By A. LONGI.

If a liquid holding in solution nitrates is mixed with a few drops of paratoluidine sulphate, and superstratified with sulphuric acid, there appears at the boundary of the two liquids an intense red colouration, which passes into a dark yellow only after a considerable time. Crude aniline may be used instead of pure paratoluidine. The red colouration can be recognised in fluids containing $\frac{1}{3\,3\,0\,0\,0}$ nitric acid. The reaction is less sensitive than that obtained with brucine and diphenylamine, but it has the advantage of producing a different colour (blue) with chloric, bromic, iodic, chromic, and permanganic acid. It can also be used for distinguishing nitric from nitrous acid, since it produces with the latter a yellow colouration which gradually passes into red.—*Gazzetta Chemica.*

DETECTION OF FREE SULPHURIC ACID IN PRESENCE OF ALUMINIUM SULPHATE.

By O. MILLER.

The author has endeavoured to utilise the azo-dyes for the detection of free sulphuric acid in cake-alums,—a matter of great importance for paper-makers. Free acid destroys the ultramarine, but precipitates fine particles of resin from the size, which appear then in the paper as transparent spots. Lunge has applied the reaction of tropeoline OO for this purpose, but the author has not met with any precise statement concerning the result. He has compared the behaviour of tropeoline and of methyl- and ethyl-orange with the reactions of logwood as formerly proposed.

His experiments show that among all known reactions those of methyl-orange afford, not merely the most certain means for the detection of free sulphuric acid in cake-alum, but also for its quantitative determination.

With this indicator he has been able to detect 0·01 grm. free sulphuric acid per litre along with 0·645 grm. aluminium sulphate, and even to show the dissociation of this salt on boiling its watery solution.

For the quantitative determination of the free acid he extracts the sample in the cold with alcohol, evaporates the alcoholic solution at a very gentle heat on the water-bath almost to dryness, re-dissolves in cold water, and titrates with decinormal alkali.

Tropeoline is not affected by neutral aluminium acetate, but it is not sufficiently sensitive to free acid. Ethyl-orange is very sensitive to free acid, but takes a rose-colour with neutral sulphate of alumina, so that the further change produced by free acid cannot be distinctly recognised.

Methyl-orange is exceedingly sensitive to free acid, and is coloured by pure, neutral aluminium sulphate, not rose, but orange, so that the change to a rose in presence of free acid is very distinct.

The other reactions which have been proposed are unsuitable. Gisecke's test with decoction of logwood has the defect that it appears only after the lapse of two or three minutes. Stein's test with ultramarine paper is not sufficiently sensitive.

The detection by evaporation on the water-bath is uncertain on account of the dissociation which sets in.—*Berichte Deutsch. Chem. Gesell.*

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Concluded from p. 9).

Corrections for Thermometers with a Limited Scale.

If the points 100° and 218° or 218° and 306° are so fixed on the scale of the mercury thermometer that they exactly agree with the measures that would be obtained by a hydrogen thermometer, a different table of corrections must be used to bring determinations made on intermediate points of the scale in agreement with the hydrogen thermometer, and the following tables give these corrections for each case of a limited scale. The 1st horizontal column gives the temperatures, and the 2nd the corrections that are to be applied (taking notice of the signs + or −) to transform degrees on the mercury thermometer into two measures of temperature as determined by the hydrogen thermometer.

Table *No.* 1.—*Scale* 100°—218°.

Temperature—	100°	110°	120°	130°	140°	150°	160°	170°
Correction—	0·00	+0·01	+0·02	+0·07	+0·13	+0·21	+0·28	+0·29
Temperature—	180°	190°	200°	210°	218°	220°	230°	
Correction—	+0·28	+0·25	+0·19	+0·09	+0·00	−0·02	−0·12	

Table *No.* 2.—*Scale* 218°—306°.

Temperature—	−0·06	0·00	+0·02	+0·09	+0·15	+0·21	+0·26
Correction—	210°	218°	220°	230°	240°	250°	260°
Temperature—	270°	280°	290°	300°	306°	310°	320°
Correction—	+0·33	+0·37	+0·30	+0·15	0·00	−0·06	−0·31

As it is supposed that the thermometers intended for this use have been subjected to a preliminary treatment at 355°, no great permanent displacement of the zero point can take place in subsequent experiments, and with a limited scale the extent of the temporary depressions and elevations of the zero point is not large; however, in accurate work this point should always be observed after a measure of temperature, and a correction made for its displacement, and the above tables are adapted to results thus corrected.

In these thermometers the value of the degree is derived from a verification of the terminal points of the scale by means of boiling water, naphthalene, or benzophenone, and if these points are inexact on the mercury thermometer, all the measures must be multiplied by the fractions representing the true value of the degree. The terminal points on the scales of these thermometers are to be determined for graduation or for verification by observing first the higher temperature, and it is well to heat several hours at this temperature to avoid any considerable displacement of the zero during graduation. The lower point is then determined as rapidly as possible.

It may be noticed that the corrections are very small compared with those which are applied to the ordinary scale running from zero to 360°, and they are almost identical for all thermometers. If smaller limits are taken for the scale, and points are fixed 50° apart in accordance with a gas thermometer, the corrections are so small for the intermediate points that no series of determinations which have been thus far made with the air thermometer are accurate enough to determine them with certainty; and the agreement between the scales of different instruments, which becomes closer as the points are taken nearer together, may be considered as almost perfect when the intervals are only 50°, and sufficiently exact for all common uses when the intervals are about 100°.

*The Evaporation of the Mercury in the Thermometer.**

When the thermometer has been made entirely vacuous of air, a rapid evaporation of mercury may be observed even at 100°, when the whole of the stem is heated in steam. If the necessary precautions are taken to set aside all other influences which would change the height of the mercury column, it may be observed to fall from minute to minute when it is watched with a good micrometric telescope; and after a quarter of an hour a variation of 0·01° or 0·02° is noticed. At high temperatures the evaporation of mercury is much more rapid, and is frequently a source of great inconvenience, disturbing the observations and dividing the mercury column by the condensation in the cooler parts of the stem. The evaporation is quite appreciable in experiments which last several days, even when the mercury is only heated 10° or 20° higher than the temperature of the air. When air is left in the stem of the thermometer the evaporation of the mercury is much retarded; but even in this case, when the stem of the thermometer is heated to 250°, a loss of mercury equivalent to several tenths of a degree may take place within half an hour. If the zero point is observed after each measure of temperature, as has been recommended, the apparent sinking of temperature caused by the evaporation of the mercury does not give rise to an error.

The Purity of the Mercury in a Thermometer.

If the mercury which is used to fill a thermometer has not been well purified, or if it has not been boiled enough in the thermometer to free the bulb and stem from air adhering to their sides, the mercury column is divided by air bubbles after long use at high temperatures. Even if the air bubble is driven into the upper reservoir, another one frequently forms in the same place, and such a thermometer becomes entirely useless. Even when it is intended to leave air in the upper reservoir, the boiling ought to be carried out as in a thermometer which is to be left vacuous, and it is advantageous to boil the mercury while the thermometer is connected with a Sprengel's pump. It seems probable, from the observations that have been made with thermometers and barometers, that when a layer of air or moisture has been left between the mercury and the glass it may serve as a channel by which further quantities of air or moisture may penetrate, and inconveniences are noticed with such instruments which certainly do not occur with those which are made with great care.

According as thermometers are well or ill made in these respects every degree of excellence may be noticed between those which will not bear a single heating, even of a few minutes at 200°, without having having the column

* This phenomenon has been noticed by everyone who has paid attention to thermometric measures, and has even been mentioned in some publications; but the errors which it may entail seem sometimes to have been neglected, and it will be seen by what has been said above that the evaporation of mercury might be a permanent cause of error in the results obtained with thermometers whose stem is left open to the air when they are heated to high temperatures.

broken, and those thermometers which are so well made that they may be heated for many days at 355° without showing the slightest air bubble in the bulb. This last was the case with four out of eight thermometers heated for eleven days and nights at 355°.

The preliminary treatment of thermometers at high temperatures, which has been frequently referred to, brings out these defects in the manufacture, and those instruments which will not bear the test must be rejected.

In connection with this subject may be mentioned a paper by Mr. Wiebe.* This author has repeated and confirmed my experiments upon the diminution of the coefficient of expansion of glass which accompanies a permanent contraction of the bulb of a thermometer, and he has published a series of interesting observations on the relation between the two phenomena which are in accordance with the principal results of my experiments. On the other hand, he considers that the permanent elevation of the zero point (in other words, the contraction of the bulb) cannot be considered as principally due to the causes which I have assigned. This opinion is partly founded upon Mr. Wiebe's incorrect determinations of zero point depressions. Those published by him for the temperature 370° are probably less than one-third of the true value; and he appears also to have been misled by a theory which it will be interesting to examine. Mr. Wiebe supposes that a gas is disengaged from the glass on heating, and that a portion of the contraction of the bulb is due to this cause. He cites the experiments of Dumas, Lockyer, Miller, who have found that several metals, as well as phosphorus, give off a gas when they are strongly heated *in vacuo*.

It might be objected that these experiments would be little conclusive if it were true that glass and porcelain were like the metals in this respect, because these substances formed the material of the apparatus which was used. But let us suppose that a contraction may really result from the disengagement of a gas which fills the intermolecular spaces of glass; we may calculate the probable extent of the contraction by taking the necessary data from well-known experiments with palladium. This is the only metal with which the phenomenon has been studied with reference to the contraction of a solid body produced by a loss of gaseous material. It may be added, however, that the results would be six or eight times more favourable to the hypothesis of Mr. Wiebe if they were based upon the solution of hydrochloric acid or of ammonia in water.

Mr. Wiebe has given no measures of the quantity of gas which was observed on heating and which separated the mercury column in his thermometers. The volume of the gas can be measured when the mercury is not made to boil, and I will take the largest quantity which I have observed as a basis for a calculation. During an elevation of the zero point equal to 17°, a bubble of gas was formed on the side of the bulb; this was eventually brought into the stem, where it separated the column of mercury and filled a space equivalent to 1·35°. The contraction of the bulb was equivalent to 0·0026 part of the total volume occupied by the mercury. This latter volume may be taken as unity, and the quantity of gas disengaged was equivalent to 0 00021 part. The volume of the glass of the bulb relatively to the mercury may be taken at 0·2, which is a usual proportion in thermometers whose bulbs and mercury are weighed for specific heat determination. (The relative volume of the glass in my thermometer was really larger.) We will suppose that only half the gas is emitted into the interior of the thermometer. We will suppose that the contraction of palladium is proportional to the quantity of hydrogen disengaged. (It is really smaller when the volume of hydrogen is small.)

It would result that a diminution of volume from 1·0026 to 1·0000 would be accompanied by an evolution of more than 15 volumes of gas. Divide this number by 2 to express that only the half of the gas disengaged by the glass of the bulb appeared in the interior of the thermometer, and by 5 because the volume of the glass is supposed to be only equal to one-fifth that of the mercury, and we find that 1·5 volume of gas should be given off if the contraction were due only to this cause.

It may be concluded that the quantity of gas disengaged in the experiment most favourable to the theory of Mr. Wiebe was 7000 times smaller than the quantity required by the calculations founded on the above hypothesis, or that $\frac{1}{7000}$ of the effect is attributable to a disengagement of gas. This discrepancy becomes still greater when it is remembered that the bubble measured was not under atmospheric pressure, as assumed in the calculation, but under a much smaller pressure, and in the experiments where no gas was disengaged no part of the phenomenon is accounted for by Mr. Wiebe's hypothesis.

It may also be observed that, did the glass of a thermometer evolve a gas in sufficient quantity to account for a notable contraction of the bulb, the pressure of this gas would be quite appreciable, even in thermometers which have an upper reservoir, while in those which have none and are particularly intended for use at high temperatures, the pressure might amount to several hundred atmospheres at a moment when the stem is filled with mercury, leaving a free space of only some 50°.

I have taken the only data known regarding a solid; but, as has already been remarked, the numbers would be more favourable to the views of Mr. Wiebe if the calculation were based upon the absorption of hydrochloric acid or ammonia by water, and the discrepancy between the facts and the theory would be reduced from 7000 to 700 if the gas were supposed to be oxygen with the same density, when condensed to a liquid, as water.* But these numbers ranging in my experiments from 700 to infinity, indicate too strong probabilities against the hypothesis in question to make it worth further consideration.

This subject has been treated under the heading of "Purity of the Mercury in a Thermometer," because it is believed that the vexatious appearance of bubbles is usually due to want of care in the manufacture of thermometers. It may be added that at temperatures so high as 370°, particularly when the mercury boils, a rapid movement of the column may imprison air from the reservoir, and that wherever a bubble has once formed it is apt to reappear. Perhaps, as has been said, the *moistening* of the glass by a gas may extend to the formation of a permanent canal along the stem, between the mercury and the glass, through which gas passes, particularly when the mercury is in rapid movement. The following experiment has some bearing on the subject:—A clean capillary tube, plunged deep under the surface of mercury, serves to suck up an unbroken column of mercury; but even a short exposure of the tube to the air of a laboratory coats it with a film of chloride of ammonium, and then when the mercury is made to flow up through it, bubbles of air are drawn down between the mercury and the outside of the capillary tube, and a broken column appears in the tube. Thus, a thermometer which has not been sufficiently cleaned is particularly liable to the defect of the formation of bubbles.

The Influence of Pressure upon a Thermometer.

The most complete series of experiments upon this subject has been made by Mr. Mills, who has studied the relation between the rise of the mercury in the stem and the pressure exercised upon the bulb of the thermometer. In one series of his experiments the rise was 0·106° for every atmosphere of pressure up to 133 atmospheres.

According to Mr. Mills, an excess of pressure of 1 atmosphere causes a rise of about 0·2°; but this factor must be determined for every thermometer separately. It appears to be in inverse ratio with the thickness of the

* *Metronomische Beitrage*, No. 3.

* The theory of M. Dumas and the experiments of M. Raoul Pictet indicate the density of liquefied oxygen is about 1.

glass, but depends also upon the form of the bulb; and it is evident that a fault in the symmetry of the bulb might considerably increase the compressibility of a thermometer.

It is apparent from the above figures that the variations in the barometric pressure may be neglected from this point of view; but it is frequently necessary to take into account the differences of pressure, which depend upon whether the thermometer is placed horizontally or vertically, and, in a long thermometer, the variations of the zero, or better, of the boiling-point, which ensue upon a change of position, may be used to calculate approximately the co-efficient of compressibility of a thermometer.

Variations of this kind must be allowed for in distillations *in vacuo*, and in all similar operations where the thermometer is subjected to a diminished or increased pressure; but it is frequently preferable to avoid such corrections by placing the thermometer in a very thin tube, closed at its lower extremity and communicating with the air at its upper end. For another reason it is frequently convenient to enclose the thermometer in an extremely thin glass tube, like those which are used for making the stems of areometers, in order to prevent the black colouring matter (usually a mixture of wax and lampblack) from being dissolved away from the division marks on the scale. If the tube is thin and of nearly the same diameter as the thermometer, and a little mercury is put in the bottom to cover the bulb, the sensitiveness of the thermometer is very little diminished, and thermometers so arranged respond more quickly to change of temperature than those of the German model, which have a portion of the bulb covered by a great thickness of glass at the point where an exterior tube containing the scale is soldered to the bulb.

Distillation.

When the substance is pure, and when the above precautions regarding the use of thermometers have been observed, errors in the determination of the boiling-point arise most frequently from too hasty operations. The mercury in the bulb takes the temperature of the vapours almost immediately, but the same is not true of the mercury column in the stem, which has to be heated through a great thickness of glass, and, what is of still more consequence during this process, the liquid which is at first condensed very rapidly on the upper part of the stem runs down and cools the bulb. Even when all the mercury column is surrounded by the vapour of the boiling substance, and the apparatus is in every way well arranged to guard against loss of heat, 5 to 10 minutes are required for the temperature to become constant, and during this period the apparatus should be held in such a position that the liquid in the condensing tube may flow back, and from time to time during the distillation it is well to heat for a few moments without allowing any substance to pass over into the recipient in order to see if a constant temperature has been attained.

With substances boiling at very high temperature it is somewhat difficult to obtain a column of vapours sufficiently long to heat the stem of the thermometer without overheating the vapours near the bulb. And where the metallic apparatus before described cannot be used, the difficulty of dealing with high-boiling substances is greatly lessened by surrounding the apparatus with a jacket at least 2 c.m. in thickness of plaster-of-Paris or asbestos cloth, leaving only a portion of the bottom of the boiling vessel exposed to the flame. This portion can be usually entirely covered with the substance which is to be distilled, so that the flame does not at any point come in contact with the part of the apparatus containing the vapours. When plaster-of-Paris is used, such an apparatus must be maintained 2 or 3 hours at high temperatures before the water is evaporated out of the plaster, and in fact the moment when the apparatus is ready for use can be observed by the very much smaller flame required to maintain active ebullition. When the glass apparatus has a disengagement tube soldered into its neck the plaster must not be allowed to set at the joint; it should be scraped away from the part while soft, although the protecting jacket should be carried about 2 c.m. higher round the neck. Where a substance is known to have the same boiling-point at the beginning and at the end of a distillation, or when the quantity of a substance is too small to admit of a fractional distillation, the boiling-point may be conveniently tested in an ordinary test-tube surrounded by a plaster cylinder; for instance, if sulphur is made to boil in this way, the plaster becomes dry after 2 or 3 hours, and then the condensation takes place almost entirely on the part of the naked tube immediately above the plaster cylinder. A cylinder so prepared and dried may be slipped over other test-tubes and used for all boiling-point determinations. Experiments with such an apparatus filled with mercury or sulphur, and using an air thermometer, have shown that the boiling-point determinations are reliable to within 0·2°.

Melting-point Determinations.

When a sufficient quantity of substance can be disposed of, it is best to introduce a small and sensitive thermometer into the liquid, and to observe all the changes of temperature during the complete solidification.

It is usual to take melting-points of small quantity of matter in a capillary tube attached to a thermometer, and both are heated in a sulphuric acid bath or in a paraffin bath* for temperatures higher then 300°. It is only necessary to remark upon a modification of this process in which the apparatus contains an interior tube, which is used as an air-bath, surrounded by sulphuric acid. This form of apparatus was devised to prevent the sulphuric acid vapours from escaping into the air, and to prevent the acid from attracting moisture. These ends could be obtained more simply otherwise, and the apparatus has a grave defect. It is only necessary to heat a large and a small thermometer together in an air-bath at changing temperatures to see that one is constantly behind the other in its indications, and it is quite certain that a small mass of substance in a capillary tube would be usually heated more quickly than a thermometer placed beside it, when they are both heated in an air-bath at rising temperatures. It is therefore indispensable in melting-point determinations to heat the thermometer and the capillary tube together in a liquid, and not in any form of air-bath. The numerous forms of apparatus proposed for observing points of fusion have often been applied with good results to special cases, but the ordinary method is on the whole the most convenient, and few substances are known of sufficient purity to demand a process of greater accuracy. The method which is most nearly perfect is that which is always used with melting ice, and it would be interesting to heat such other solids as can be obtained pure in sufficient quantities in an air-bath at a temperature somewhat higher than their melting-points and to observe the degree of constancy attained by a thermometer properly surrounded by the melting solid.—*American Chemical Journal*, vol. v., No. 5.

THE NEW CHEMICAL LABORATORIES OF THE SWISS POLYTECHNIC SCHOOL AT ZURICH.

THE old chemical laboratories of the Polytechnicum of Zurich having proved inadequate to accommodate the number of students resorting to that Institution in ever-increasing numbers, the Federal Parliament has just voted funds for constructing new laboratories which promise to be among the largest and finest ever erected.

* It is not difficult to find English paraffin candles which are so well purified that after distilling a small portion of the more volatile hydrocarbons it enters into active boiling above 370°.

The sum now voted (1,337,000 francs) will only cover the buildings proper, the internal fittings will cost another 300,000 to 400,000 francs, so that the total will amount to the magnificent sum of about £70,000. Nor will this money be spent to any great extent upon handsome frontages, columns, and similar ornamental appendices, as has been done in some other well-known laboratories, but the exterior is to be kept as plain as possible, all the more funds being left for making the interior as spacious, comfortable, and well-appointed as possible.

The plans of the building have been drawn by the professors of architecture, Messrs. Bluntschli and Lasius, on the lines laid down by the present professors of chemistry, Dr. Victor Meyer and Dr. Lunge. There will be a central building, 288 feet long and 67 feet wide, flanked at each end by two aisles at right angles, of 100 feet length and 38 feet width, and a similar aisle in the centre at the back, *i.e.*, altogether five aisles of an aggregate length of 500 feet. The central building will be three-storied; the aisles two-storied. They will principally accommodate the two great laboratories, that of "analytical chemistry," (Dr. V. Meyer's), for 100 students, and that of "technical chemistry" (Dr. Lunge's) for 80 students. A comparatively small portion of the building is taken up by the Institute of Pharmacy, the agricultural control station, and the assaying office for gold and silver. The whole is situated in a commanding position, a little above the Polytechnicum, with a splendid view of the Lake and the Alps. Each student will have from two to three times more room and corresponding facilities at his disposal than is at present the case in the best existing laboratories. Special care will be taken to insure the best possible ventilation by means of a powerful steam-engine, a chimney 100 feet high, and numerous small shafts for the single draught-places which will be at everybody's elbow. Motive power will be supplied, more especially for the technical laboratory, in which operations on a comparatively large scale will be possible. Special large rooms will be fitted up for dyeing, for photography, and further purposes. The whole will be finished and ready for a start in the summer of 1886, at which period the Federal Government is bound by treaty to hand over the present laboratories to the Canton of Zurich for its own use.

It seems worthy of notice that the Swiss Confederation, which numbers only two-thirds of the inhabitants of London, spends this large sum upon an institution which is freely open to all the world. Only about one-third of the students are Swiss, two-thirds are foreigners, among them a number of Englishmen and Americans.

UNIFORM ANALYTICAL METHODS.

The following letter has been sent to the members of the Society of Chemical Industry:—

Zurich, Switzerland, April, 1883.

Dear Sir,—The Committee of the German Society for the promotion of Chemical Industry has resolved, upon a suggestion made by the representative of the chemical manufacturers, to submit to the next General Meeting of the Society the following proposals, viz.:—

"That steps may be taken for bringing about an International Agreement concerning uniform analytical methods for estimating the commercial value of certain products."

I have been honoured with the request to lay a report upon this matter before the meeting, and for this purpose I take the liberty of addressing myself to you, to obtain the favour of your opinion thereon.

It will not be doubted that the confusion at present reigning in that matter is very awkward indeed. In the transactions between manufacturers and their buyers and sellers, unpleasant discussions or even lawsuits are frequently caused by the employment of different methods of sampling, or testing, or both—methods which must needs lead to differing results; and an appeal to a commercial analyst sometimes increases the confusion by the introduction of a third method. This would be avoided, if all those concerned were agreed upon employing certain standards for sampling and testing the goods, the same specific gravity tables, and so forth.

It is, moreover, most desirable that the results of analysis should be expressed in an uniform manner. Mutual understanding is greatly impeded if, for instance, one party calculates phosphoric acid as such, the second as tricalcic phosphate, the third perhaps as monocalcic phosphate. The strength of soda-ash is expressed in a different way each in England, France, and Germany, and many other similar instances might be quoted. Not merely for commercial purposes, but also for comparing results of work it would be most desirable to establish some such agreement. An English acid maker, who learns that his German neighbour consumes so much nitric acid at 36° Baumé for each cwt. of sulphuric acid, has no notion what that may mean in terms of 96 per cent nitrate of soda per 100 parts of sulphur, &c.

A considerable portion of the German chemical manufacturers have taken steps for improving this state of affairs, at least within their own country. The chemical manure makers have agreed upon uniform and binding modes of testing, and the alkali trade is aiming at the same object by means of a Manual for Alkali, Potash, and Ammonia-works, just published. The success already attained in this direction in Germany has been an encouragement to conceive the idea that the great advantage of uniform methods might be extended internationally, and it is just the object of the present communication to gather information about the possibility of realising this.

Nobody, of course, will overlook the difficulties standing in the way of such an agreement. Some of the countries concerned do not even possess suitably organised unions of chemical manufacturers, and international unions of such a character are altogether out of the question. Even if such existed, they would never succeed in *compelling* their members to employ certain methods, or even the same way of expressing the results, and still less would they be able to exert such a compulsion upon the buying and selling public and the commercial analysts. Nor can it be denied that great differences of opinion exist as to the value of many analytical methods, and that constantly new, if not always better, methods come to the fore. Hence, a rigid, compulsory code, binding for ever, or even for a long period, is not to be thought of. But, on the other hand, those go too far who for this reason deny the possibility or even the desirability of an agreement in this respect. Even in public matters no law can be made which embodies absolute truth and justice; in the long run, with changing circumstances, the best laws become unsuitable and must be changed; but nobody pretends that therefore we must do without laws altogether. Without laying too much stress upon this simile, it will be conceded that an agreement among the leading manufacturers and chemists of the great industrial countries upon the matters concerned, even though it would not either possess or claim absolute binding power, would be invested with sufficient authority to serve in a large majority of cases as a standard in the intercourse between buyers and sellers. It would soon become a regular practice to stipulate for those standards in contracts and sale notes, and they would be acknowledged as decisive in Courts of Laws.

With this view I beg to lay the following questions before you, in the respectful hope of receiving as full an answer as possible, to be made use of, either with mention of name or otherwise, as you may wish, in my report to the meeting of German chemical manufacturers.

1. Do you believe that an international agreement, concerning exact standards of *sampling* ores, raw products, and chemicals could be attained?
2. Do you believe that a similar agreement could be attained in the matter of *analytical methods*, and

more particularly in which definite branches of industry?

3. Do you believe that in some definite branches of chemical industry an uniform international *way of expressing the results* could be agreed upon, and have you any specific proposals to make in this respect?
4. In case you should answer one or more of the above questions in the affirmative, what *organs* would you think suitable for establishing an international agreement?
5. Do you think that such agreements should be made for an indefinite time, or that their *revision*, evidently called for from time to time, should be from the first provided for by a periodical action of the just mentioned organs?
6. In what *form* do you think that the results of such an agreement should be made accessible to the public?

Whatever your opinion may be upon those points, I shall consider it a special favour if you will impart it to me at your convenience, in order to make use of it in my official report.—I have the honour to be dear Sir, yours most respectfully,

GEORGE LUNGE, Ph.D.
Professor of Technical Chemistry at the Federal Polytechnic School, Zurich.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ZINC.

THE several determinations of the atomic weight of zinc are by no means closely concordant. The results obtained by Gay-Lussac† and Berzelius‡ were undoubtedly too low, and may be disregarded here. We need consider only the work done by Jacquelain, Favre, and Axel Erdmann.

In 1842 Jacquelain published the results of his investigations upon this important constant.‖ In two experiments a weighed quantity of zinc was converted into nitrate, and that by ignition in a *platinum* crucible was reduced to oxide. In two other experiments sulphuric acid took the place of nitric. As the zinc contained small quantities of lead and iron, these were estimated, and the necessary corrections applied. From the weights of metal and oxide given by Jacquelain the percentages have been calculated:—

Nitric Series.

9·917 grms.	Zn gave	12·3138	ZnO.	80·536 per cent Zn
9·809	,,	12·1800	,,	80·534 ,,

Sulphuric Series.

2·398	,,	2·978	ZnO.	80 524 ,,
3·197	,,	3·968	,,	80·570 ,,

Mean of all four, 80·541 ± 0·007

Hence Zn = 66·072 ± 0·028.

The method adopted by Axel Erdmann§ is essentially the same as that of Jacquelain, but varies from the latter in certain important details. First, pure zinc oxide was prepared, ignited in a covered crucible with sugar, and then, to complete the reduction, ignited in a porcelain tube in a current of hydrogen. The pure zinc thus obtained was converted into oxide by means of treatment with nitric acid and subsequent ignition in a *porcelain* crucible. Erdmann's figures give us the following percentages of metal in the oxide:—

80·247
80·257
80·263
80·274

Mean 80·260 ± 0·0037

Hence Zn = 64·9045 ± 0·019.

If we combine the results of Jacquelain with those of Erdmann, we get a mean percentage of zinc, 80·324 ± 0·0032; and an atomic weight of Zn = 65·168 ± 0·018. The reason for the discordance between the two experimenters will be considered further along.

Favre* employed two methods of investigation. First, zinc was dissolved in sulphuric acid, the hydrogen evolved was burned, and the weight of water thus formed was determined. To his weighings I append the ratio between metallic zinc and 100 parts of water:—

25·389 grms.	Zn gave	6·928	grms. H_2O.	366·469
30·369	,,	8·297	,,	366·024
31·776	,,	8·671	,,	366·463

Mean 366·319 ± 0·088

Hence Zn = 65·803 ± 0·020.

The second method adopted by Favre was to burn pure zinc oxalate, and to weigh the oxide and carbonic acid thus produced. From the ratio between these two sets of weights the atomic weight of zinc is easily deducible. From Favre's weighings, if $CO_2 = 100$, ZnO will be as given in the third column below:—

7·796 grms.	ZnO = 8·365	grms.	CO_2.	93·198
7·342	,,	7·883	,,	93·137
5·2065	,,	5·588	,,	93·173

Mean 93·169 ± 0·012

Hence Zn = 65·8395 ± 0·022.

A fourth combustion of the oxalate is omitted from the above series, having been rejected by Favre himself. In this the oxide formed was contaminated by traces of sulphide.

The four values for zinc now before us are so discordant that a combination of them after the usual method can have only a trifling significance. The following is the result thus obtained:—

From Jacquelain's figures ..	Zn = 66·072 ±	0·028
From Favre's water series ..	,,	65·803	0·020
From Favre's oxalate series..	,,	65·8395	0·022
From Erdmann's figures ..	,,	64·9045	0·019
General mean	,,	65·557	0·011

It will be seen that three of these values agree tolerably well, placing the atomic weight of zinc in the neighbourhood of 66, while the other is, in round numbers, about a unit lower. This lower figure, however, has the smallest probable error, and it will be found also, upon careful consideration, that it is less likely than the others to be vitiated by experimental inaccuracies. Both chemically and mathematically it is the best.

Upon comparing Erdmann's results with those of Jacquelain two points are worth noticing: first, Erdmann worked with purer material than Jacquelain, although the latter applied corrections for the impurities which he knew were present; secondly, Erdmann calcined his zinc nitrate in a porcelain crucible, while Jacquelain used platinum. In the latter case it has been shown that portions of zinc may become reduced and alloy themselves with the platinum of the crucible. Hence a lower weight of oxide from a given quantity of zinc, a higher percentage of metal, and an increased atomic

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Mémoire d'Arceuil*, 2, 174.
‡ *Gilb. Annal.*, 37, 460.
‖ *Compt. Rend.*, 14, 636.
§ *Poggend. Annal.*, 62, 611. *Berz. Lehrb.*, 3, 1219.

* *Ann. Chim. Phys.*, (3,) 10, 163. 1844.

weight. This source of constant error has undoubtedly affected Jacquelain's experiments, and vitiated his results. In Erdmann's work no such errors seem to be present.

Over Favre's experiments Erdmann's have the important merit of simplicity. In the latter it is difficult to detect sources of error; in the former it is easy. In Favre's water series it was essential that the hydrogen should first be thoroughly dried before combustion, and then that every trace of water formed should be collected. A trivial loss of hydrogen or of water would tend to increase the apparent atomic weight of zinc.

In the combustion of the zinc oxalate equally great difficulties are encountered. Here a variety of errors are possible, such as are due, for example, to impurity of material, to imperfect drying of the carbon dioxide, and to incomplete collection of the latter. It may not be easy to prove that such errors actually did creep into Favre's work, and yet their possibility hinders us from absolutely accepting his results.

All things considered, then, Erdmann's determination of the atomic weight of zinc is the one most entitled to credit, and must be taken for the present in lieu of the general mean deduced from all four of the values. This determination, $Zn = 64{\cdot}9045 \pm 0{\cdot}019$, becomes, if $O = 16$, 65·054.

The following additional note has been communicated by the author :—

Marignac has very lately re-determined the atomic weight of zinc by a complex process depending upon the complete analysis of the double salt $ZnCl_2.2KCl$. In eight experiments the mean value obtained is $Zn = 65{\cdot}305$. (With $O = 16$, and Stas's values for As, K, and Cl). Marignac objects to Erdmann's results on the ground that ZnO resulting from the calcination of the nitrate always contains nitrous impurities. This would render Erdmann's determination too low. (*Arch. des Sci. Phys. et Nat.* (3), 10, 194).—F. W. C.

CADMIUM.

The earliest determination of the atomic weight of this metal was by Stromeyer, who found that 100 parts of cadmium united with 14·352 of oxygen.* With our value for the atomic weight of oxygen these figures make $Cd = 111{\cdot}227$. This result has now only a historical interest.

The more modern estimates of the atomic weight of cadmium are four in number, by v. Hauer, Lenssen, Dumas, and Huntington. Of these that by v. Hauer† comes first in chronological order. He heated pure anhydrous cadmium sulphate in a stream of dry hydrogen sulphide, and weighed the cadmium sulphide thus obtained. His results were as follows, with the percentage of CdS in $CdSO_4$ therefrom deduced :—

7·7650 grms.	$CdSO_4$ gave	5·3741	CdS.	69·209 per cent.
6·6086	,,	4·5746	,,	69·222 ,,
7·3821	,,	5·1117	,,	69·245 ,,
6·8377	,,	4·7336	,,	69·228 ,,
8·1956	,,	5·6736	,,	69·227 ,,
7·6039	,,	5·2634	,,	69·220 ,,
7·1415	,,	4·9431	,,	69·217 ,,
5·8245	,,	4·0335	,,	69·251 ,,
6·8462	,,	4·7415	,,	69·257 ,,

Mean 69·231 ± 0·0042

Lenssen‡ worked upon pure cadmium oxalate, handling however only small quantities of material. This salt, upon ignition, leaves the following percentages of oxide :—

0·5128 grm.	oxalate gave	0·3281	CdO.	63·982 per cent.
0·6552	,,	0·4193	,,	63·996 ,,
0·4017	,,	0·2573	,,	64·053 ,,

Mean 64·010 ± 0·014

Dumas* dissolved pure cadmium in hydrochloric acid, evaporated the solution to dryness, and fused the residue in hydrochloric acid gas. The cadmium chloride thus obtained was dissolved in water and titrated with a solution of silver after the usual manner. From Dumas's weighings I calculate the ratio between $CdCl_2$ and 100 parts of silver :—

2·369 grms.	$CdCl_2$ =	2·791	grms. Ag.	84·880
4·540	,,	5·348	,,	84·892
6·177	,,	7·260	,,	85·803
2·404	,,	2·841	,,	84·618
3·5325	,,	4·166	,,	84·794
4·042	,,	4·767	,,	84·791

Mean 84·843 ± 0·026

Latest of all comes Huntington's† work done under the direction of Professor J. P. Cooke. Bromide of cadmium was prepared by dissolving the carbonate in hydrobromic acid, and the product, dried at 200°, was purified by sublimation in a porcelain tube. Upon the compound thus obtained two series of experiments were made.

In one series the bromide was dissolved in water, and a quantity of silver not quite sufficient for complete precipitation of the bromine was then added in nitric acid solution. After the precipitate had settled, the supernatant liquid was titrated with a standard solution of silver containing 1 grm. to the litre. The precipitate was washed by decantation, collected by reverse filtration, and weighed. To the weighings I append the ratio between $CdBr_2$ and 100 parts of silver bromide :—

Grms.		Grms.		
1·5592	$CdBr_2$ gave	2·1529	AgBr.	Ratio 72·423
*3·7456	,,	5·1724	,,	72·415
2·4267	,,	3·3511	,,	72·415
*3·6645	,,	5·0590	,,	72·435
*3·7679	,,	5·2016	,,	72·437
2·7938	,,	3·8583	,,	72·410
*1·9225	,,	2·6552	,,	72·405
3·4473	,,	4·7593	,,	72·433

Mean 72·4216 ± 0·0028

The second series was like the first, except that the weight of silver needed to effect precipitation was noted, instead of the weight of silver bromide formed. In the experiments marked with an asterisk, both the amount of silver required and the amount of silver bromide thrown down were determined in one set of weighings. The third colvmn gives the $CdBr_2$ proportional to 100 parts of silver :—

*3·7456 grms.	$CdBr_2$ =	2·9715	grms. Ag.	126·051
5·0270	,,	3·9874	,,	126·072
*3 6645	,,	2·9073	,,	126·045
*3·7679	,,	2·9888	,,	126·067
*1·9225	,,	1·5248	,,	126·082
2·9101	,,	2·3079	,,	126·093
3·6510	,,	2·8951	,,	126·110
3·9782	,,	3·1551	,,	126·088

Mean 126·076 ± 0·0052

From the first series ..	$CdBr_2$ =	271·498	± 0·032
From the second series ..	,,	271·505	0·027
General mean	,,	271·502	0·0215

Hence $Cd = 111{\cdot}966 \pm 0{\cdot}043$.

* See Berzelius's "Lehrbuch," 5th Ed., 3, 1219.
† *Journ. f. Prakt. Chemie*, 72, 350. 1857.
‡ *Journ. f. Prakt. Chem.*, 79, 281. 1860.

* *Ann. Chem. Pharm.*, 113, 27. 1860.
† *Proc. Amer. Acad.*, 1881.

According to Huntington's own calculations these experiments fix the ratio between silver, bromine, and cadmium as Ag : Br : Cd : : 108 : 80 : 112·31. This result militates strongly against Prout's hypothesis.

Upon combining all the determinations we get the following result:—

v. Hauer	Cd = 111·684	±	0·040
Lenssen	,, 111·803		0·062
Dumas	,, 111·969		0·065
Huntington	,, 111·966		0·040
General mean ..	,, 111·835		0·024

Or, if O = 16, then Cd = 112·092.

It will be seen that Dumas and Huntington's determinations both made with haloid salts of cadmium, agree with wonderful closeness, and so confirm each other. On the other hand, v. Hauer's data give a value for the atomic weight of cadmium which is much lower. Apparently v. Hauer's method was good, and the reason for the discrepancy remains to be discovered. Until it is ascertained I prefer to use the above mean value for Cd, rather than to adopt one investigation and reject the others.

CORRESPONDENCE.

VAPOUR-PRESSURE OF MERCURY.

To the Editor of the Chemical News.

SIR,—Mr. R. B. Warder's criticisms are very just, and the difficulties that have occurred to him presented themselves to me when the experiments were first commenced. I endeavoured, however, to facilitate the diffusion of the mercury vapour in the air of the flask by hanging the tube just at the bottom of the neck, and also by filling the tube brim-full of mercury, so that the meniscus was level with the edge of the tube. These details ought to have been stated in the paper.

The first experiment was to me very inconclusive, and it was only the very concordant result obtained by the second, under the conditions of prolonged time and increased mercury surface, that made me think the result worthy of record,—I am, &c.,

HERBERT MCLEOD.

Cooper's Hill, January 5, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 24, December 10, 1883.

A New Compound of Rhodium.—H. Debray.—On fusing finely-divided rhodium with twenty or thirty times its weight of iron pyrites, the author obtained a regulus which, when treated with hydrochloric acid, leaves a deposit of black scales of a semi-metallic appearance. This deposit, whilst still moist, is entirely soluble in dilute nitric acid. This product is not a rhodium sulphide, but contains about 9·6 per cent of water, 17·2 of sulphurous acid, or 8·6 of oxygen, and 73·2 of rhodium sulphide. A new study of the amorphous residues obtained on dissolving the regulus of iron pyrites and the metals of the platinum group is necessary.

Formulæ showing the Electric Resistance of the Circuit employed in Edison's System of Lighting.—G. Gueroult.—A purely mathematical paper.

Researches on the Solidification of Superfused Sulphur (Second memoir).—D. Gernez.—Sulphur which has been heated to near 170° undergoes a modification which persists when it is caused to remain in the superfusion bath, and it is remarkable to note that if the temperature has been raised much above 170°, although the liquid again passes by this temperature when it is brought into the superfusion-bath, it crystallises as rapidly as if it had been heated to a temperature little higher than the point of fusion.

Determination of the Atomic Weight of Aluminium by Means of its Sulphate.—M. Baubigny.—The author's mean result is Al = 13·508 if S = 16, and Al = 13·532 if S = 16·037.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—If iodoform is intimately mixed with moist powdered silver, it rapidly yields acetylene, even in the cold.

Moniteur Scientifique, Quesneville.
December, 1883.

Patents obtained Abroad.—Abstracts of specifications, chiefly German, relating for the most part to the manufacture of coal-tar colours.

The Manufacture of Aluminium.—W. Weldon.—From the *Journal of the Society of Chemical Industry.*

Salt Works of Giraud en Camargue.—Professor G. Lunge.—A very full account of a visit to the "salines" of Péchiney and Co., in the island of Camargue between the two main mouths of the Rhône. After sodium chloride has been obtained from the salt water, the mother-liquors serve for the extraction of salts of potassium and magnesium, and for the manufacture of sodium sulphate. The marketable products are anhydrous sodium sulphate, magnesium sulphate, potassium chloride, and certain mother-liquors, which, if needful, may be treated further for the extraction of bromine. The potassium chloride is used partly as manure, and partly in the manufacture of potassium chlorate.

The Helvetic Society.—At the 66th meeting of this Society the chemical section was presided over by Prof. Wislicenus. Prof. V. Meyer, of Zurich, gave an address on the nature of the chemical elements according to recent researches. He discussed the possibility of a decomposition of the so-called elements, but admitted that for the present it had not been possible to resolve any element into substances qualitatively different.

Prof. Krafft, of Bâle, exhibited certain of the higher alcohols of the series $C_n H_{2n+2}O$, and added some remarks on the series of alcohols in general.

Prof. L. Soret, of Geneva, gave a summary of his researches on the absorption of the ultra-violet rays by various substances of animal origin.

Dr. M. Cérésole, of Lausanne, read a paper on the acetacetic acids.

Prof. V. Meyer exhibited apparatus for the determination of the density of gases at very high temperatures. He exhibited also the thiophene which he has discovered in coal-tar benzol.

Prof. Schulze, of Zurich, described researches which he had undertaken in common with M. J. Barbieri, on phenyl-amido-propionic acid, and also spoke concerning certain substances which enter into the composition of the cheese of Emmenthal, such as caseoglutine, leucine, tyrosine, and zinc lactate.

Prof. Wislicenus gave a communication on the relation which exists between the optical rotatory power of the carbides of hydrogen, and the existence of an atom of non-symmetric carbon. He also discoursed on the products of the reaction of phthalyl dichloride with a sodium compound of malonic ether.

Prof. E. Schaer, of Zurich, gave a historical communication on the researches of F. L. Desaive, a pharmacist, of Liège, who flourished in the last century.

Dr. H. Goldschmidt discussed the action of hydroxylamine upon the quinones.

Dr. E. Schuhmacher-Kopp related certain observations made by him as "cantonal chemist" at Lucern.

Prof. G. Lunge, of Zurich, spoke concerning the formation of sulphuric acid in the lead chambers, basing his remarks on results obtained at his instigation by M. Naef at the Uetikon works.

Dr. Urech spoke on the relation which exists between the chemical mass and the speed of reaction during the reduction of Fehling's liquid by invert-sugar. He discussed also the action of certain salts on the speed of inversion of saccharose, and described certain experiments undertaken to show that the constants of the speed of inversion depend on the nature of the acids employed. He also exhibited a lamp fed with petroleum ether.

M. Raoul Pictet read a communication on the manufacture of wood-paste by the use of sulphurous acid and of low temperatures.

Industrial Society of Mulhouse: Meetings of the Chemical Committee.—Meeting of September 12, 1883.—It was noted that the fixation of colours by means of gelatine was due, not to M. Fauquet, but to M. Lucas, chemist to the firm of Fauquet.

MM. Schlieper and Baum make certain corrections in their memoir on direct printing with indigo. The alumina is not in the gelatinous state, but is a dry hydrate. The authors prefer the soft Java indigoes to the harder Bengal sorts, although the latter are richer in indigotine.

The Committee received from M. Rotondi two pamphlets, "On the Electro-decomposition of Cadmium Chloride and the Industrial Applications of this Reaction," and on "The Action of Electrolysis upon a Solution of Pyrogallic Acid."

Meeting of October 16.—MM. Noelting and Wild have studied amido-azo-β-naphthaline.

MM. Noelting and Forel have prepared amido-azo-meta-xylol.

Biological Society.—Meeting of November 9.—An account of the French expedition to Egypt for the study of the cholera.

Electric Experiments at Brussels.—Experiments on the economy of the Gramme accumulator for lighting purposes and for traction. The results are described as satisfactory.

Insoluble Phosphates.—F. J. Lloyd.—From an English source.

Use of Boric Acid and Hematoxyline in Alkalimetry.—A. Guyard.—The author proposes to employ the boric acid in place of the sulphuric acid as a standard, easily procured in a state of purity, and by which it is easy to prepare a truly normal sulphuric acid. As indicator he proposes hæmatoxyline. It must be dissolved in distilled water immediately before being wanted. The solution thus obtained may serve for a day, but not longer. With this indicator the distinction between strong and weak acids disappears, boric acid producing as decided a change of colour as sulphuric acid. A few drops of a weak solution of hæmatoxyline give, with any acid liquid whatever, a light yellow colour perfectly distinct. Alkalies turn the colour to a distinct and relatively permanent purple. Hæmatoxyline is also, according to the author, one of the most delicate reagents for ammonia, and may perhaps even prove more valuable than Nessler's reagent. If traces of ammonia exist in a liquid, then, at the moment of the saturation of an acid by an alkali, the yellow tint of the hæmatoxyline is turned to a delicate violet by the formation of hæmateine. The author considers that this reaction will be of especial value in the alkalimetric determination of nitrogen.

Preparation of the Nitro-molybdic Reagent at its Maximum Concentration.—A. Guyard.—The author dissolves in a large beaker ammonium molybdate, in powder or in crystals, until it is no longer taken up on stirring. The liquid thus prepared is strongly acid to litmus. He places then in smaller glasses 15 to 20 c.c. of a nitric acid made up of equal measures of the strongest acid and of water. He then pours gradually, and with constant stirring, the ammonium molybdate into the acid until the white precipitate, which is formed and disappears, renders the liquid slightly milky. It is then cleared by the addition of a drop of nitric acid, and left to become completely cold. By each such operation there are produced 125 to 150 c.c. of the reagent at its maximum concentration. It is not judicious to attempt the preparation of larger quantities in one and the same glass.

Detecting Bismuth in Commercial Lead, and Manganese in Zinc Ash, Calamine, and Commercial Zinc.—A. Guyard.—This paper will be inserted in full.

The Golden Sulphide of Antimony and the Caoutchouc Industry.—V. Roussel.—Not adapted for useful abstraction.

An Explosion of Dynamite.—An account of an explosion which took place at the Paulilles works on January 25, 1883, proving fatal to all the persons present, who were for the most part reduced to small fragments, and scattered over a space of 150 to 200 metres. A house situate at 400 metres from the works was fractured from top to bottom, though the trees which separated it from the works were not at all damaged. (A feature which should be remembered by the authorities before licensing works for the manufacture of explosives in the neighbourhood of dwelling houses, &c.)

Archives Neerlandaises des Sciences Exactes et Naturelles, Tome xviii., Part 4.

A Contribution to the Knowledge of Quinovic Acid, Quinovine, and Quinovite.—A. C. Oudemans, Jr.—The author's observations upon α-quinovine agree with those of MM. Liebermann and Giesel. This compound, under the influence of acids, is split up into quinovic acid and a kind of sugar, which the author calls quinovite. He has not been able to confirm Rochleder's observation that the same decomposition is effected by sodium amalgam. M. Oudemans considers that the composition of quinovic acid is best expressed by the formula $C_{33}H_{52}O_6$. Quinovite is not identical with mannitane, as Berthelot assumes. Its composition may be provisionally stated as $C_6H_{12}O_4$. It is dextro-rotatory, and is very easily oxidised by nitric acid, with abundant formation of oxalic acid. Amongst the products formed by the action of sulphuric acid upon quinovic acid was a small quantity of a compound, probably identical with the quino-chromine of Liebermann and Giesel, and, on one occasion, there was found a very small quantity of a hydrocarbon which the author calls quinovine. Another product obtained from the alcoholic mother-liquor of quino-chromine is apoquinovic acid, to which the author ascribes the formula $C_{16}H_{26}O_4$.

Diffusion of Certain Organic and Inorganic Compounds.—J. D. R. Scheffer.—A long and important paper, but incapable of useful attraction.

Justus Liebig's Annalen der Chemie, Vol. 221, Part 3.

Communications from the Chemical Laboratory of the University of Erlangen.—These consist of a memoir by E. Fischer and H Kuzel on the hydrazines of cinnamic acid; a paper by L. Knorr on piperyl-hydrazine; an account of the hydrazine compounds of phenol and anisol, by Herm. Reisenegger, in which the author remarks that the hydrazines are chiefly distinguished from the amine bases by their want of stability in presence of oxidising agents; a paper by H. Gevekoht on the preparation of the three nitro-aceto-phenones; and a memoir by Emil Fischer and L. Reese on caffeine, xanthine, and guano.

Communications from the Chemical Laboratory of Griefswald.—We have here a paper by Dr. A. Heffter on para-amido-toluol-ortho-thio-sulphonic acid, and a memoir by Dr. W. Paysan on ortho-amido-toluol-para-thio-sulphonic acid.

Methyl-arbutine, Benzyl-arbutine, and Benzyl-di-oxy-benzoles.—H. Schiff and G. Pellizzari.—The authors have succeeded in converting natural arbutine into benzyl-arbutine, and in obtaining from it methyl-arbutine in pure crystals, which are evidently identical with artificial methyl-arbutine.

Cosmos les Mondes.
No. 12, November 17, 1883.

Atomic Movements.—Marcellin Langlois.—A mathematical paper, not capable of useful abstraction.

MEETINGS FOR THE WEEK

MONDAY, Jan. 14th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 15th.—Royal Institution, 3. "Coins and Medals," by Mr. R. S. Foote.
—— Institute of Civil Engineers, 8.
—— Pathological, 8.30
WEDNESDAY, 16th.—Society of Arts, 8.
—— Meteorological, 7. (Anniversary.)
THURSDAY, 17th.—London Institution, 7.
—— Royal, 4.30.
—— Philosophical Club, 6.30
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
—— Chemical, 8. "On Camphoric Peroxide and Camphorate of Barium," by C. T. Kingzett. "On the Decomposition of Silver Fulminate by Hydrochloric Acid," by E. Divers, M.D., and Michitada Kawakita, M.E.; "Supplementary Note on Liebig's Production of Fulminating Silver without the use of Nitric Acid," by Edward Divers M.D., and Michitada Kawakita, M.E. "On Hyponitrites," by Edward Divers, M.D., and Tamemasa Haga.
FRIDAY, 18th.—Royal Institution, 9. "Rainbows," by Prof. Tyndall.
SATURDAY, 19th.—Royal Institution, 3 "Life and Literature under Charles I.," by Prof. Morley.

ANALYTICAL AND CONSULTING CHEMIST.—Mr. H. S. CARPENTER, F.I.C., F.C.S., Member of the Society of Public Analysts, &c., performs Analyses of Commercial and Agricultural Samples, Minerals, &c.; also of articles of food and drink, drugs, poisons, gases, waters, &c. Scale of Fees forwarded on application.—The Metropolitan Laboratory, 32, Holborn Viaduct, E.C.

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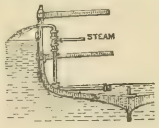

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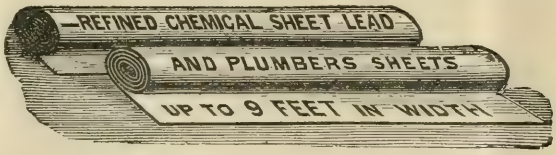

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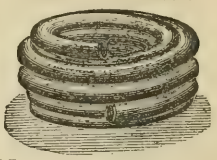

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Wanted.—"Researches on the Solar Spectrum and the Spectra of the Chemical Elements," by G. Kirchhoff. (*First part.*) Translated by Prof. Roscoe.—Address. H.E., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1260.

VOLUMETRIC ESTIMATION OF MANGANESE.

By ALEX. J. ATKINSON.

In the Chemical News, vol. xlix., p. 9, Mr. Holdich suggests a modification of the indirect method of estimating manganese in spiegeleisen. It may be a matter of some interest that, when chemist to the Blaenavon Company, I used, for over three years, precisely the same method of estimating manganese in spiegeleisen, containing as a rule 20 per cent of manganese, and that, unless I am greatly mistaken, the same method is in regular use in the Dowlais Laboratory, where I believe I first saw it.

Having found by comparison with gravimetric determinations that the results were uniformly from 0·2 to 0·5 per cent too low, I felt justified in passing several thousands of tons of speigeleisen upon the basis of these determinations, the laboratory results being well borne out by those obtained at the Bessemer works. In the event, however, of any sample yielding by the method in question less manganese than 0·5 per cent below the amount guaranteed, a check determination was made by the gravimetric method, and, to the best of my remembrance, in each case gave results between 0·2 and 0·5 per cent above what had been found by the indirect method. I have adopted the same method for the estimation of manganese in samples of ferromanganese containing from 60 to 70 per cent of that metal, by deducting (per cent Fe + per cent Si + 6) from 100. The results were, however, by no means so regular as in the case of spiegeleisen: one cause of the irregularity being the difficulty of thoroughly dissolving the ferromanganese. More carbon being present in the ferromanganese, more hydrocarbons are liberated during its solution, and these of a more oily nature than in the case of spiegeleisen. This oily matter adheres to the small particles of the alloy, retains bubbles of hydrogen gas, and is thus the means of a portion of the fine powder being carried to the surface, and withdrawn from the solvent action of the acid. With ferromanganese I have found variations to the extent of over 1 per cent, the results being higher than those given by the gravimetric method.

For steel works, where absolute accuracy is not essential, I consider that the indirect method, when the variation in the percentage of silicon is taken into account, is well adapted, but I would not, of course, recommend it for use by commercial analysts.

With regard to the estimation of silicon I have, both on account of rapidity and of freedom from hydrochloric acid fumes, preferred the following method to the one mentioned by Mr. Holdich. It is applicable to pig-iron, spiegeleisen, steel, or wrought-iron, and gives, with considerably less trouble, a purer residue of silica than is obtained by the hydrochloric acid method. A dilute solution of sulphuric acid is prepared by mixing with six volumes of water, one volume of strong pure sulphuric acid; in this dilute acid the material is dissolved. 1·5 or 2 grms. of spiegel, &c., are dissolved in 22 or 30 c.c. of the dilute sulphuric acid in a covered beaker on a hot plate; when all the metal is dissolved, the cover is washed and removed, and the solution evaporated, rapidly at first and more cautiously as soon as the granular ferrous sulphate begins to separate out. During the latter portion of the evaporation occasional shaking is necessary to avoid the formation of a crust over the surface, which would retard further evaporation. When this evaporation is carried out with due care, the ferrous sulphate sets quite firm upon the bottom of the beaker, and the whole of the water may be driven off. When dry the ferrous sulphate is allowed to cool, and is then dissolved in hot water, boiled, and filtered through a washed filter. The silicon and graphite collected on the filter are then well washed, dried, and ignited at a bright red heat over a burner, or preferably in a muffle. The silica thus obtained is practically pure, and contains no oxide of iron, as is frequently the case with the silica obtained by dissolving in hydrochloric acid. An advantage of this method is the rapidity with which the hot solution of ferrous sulphate may be filtered and washed, whereas when hydrochloric acid is employed the ferrous chloride solution is more largely converted into ferric chloride, a solution of which filters exceedingly slowly. In conclusion, I may add that I claim no originality for this method, for I know it to be in use in other laboratories, notably at Dowlais.

44, Loudoun Square, Cardiff,
January 5, 1884.

INFLUENCE OF TIME IN FERTILISER ANALYSES.

By ROBERT B. WARDER.

The estimation of "reverted phosphoric acid" is acknowledged to be one of the most unsatisfactory parts of an analysis of commercial fertilisers. Since a somewhat arbitrary distinction must be made, it is very desirable to secure uniformity by having some definite standard that will meet with general acceptance among chemists engaged in these analyses; and in this respect, at least, the "Washington method" with neutral citrate of ammonia has had its merits. The conditions were so defined, however, by the convention of 1880, that the solvent action must often be arrested *while it is still progressing with considerable rapidity;* so that small variations in the time and temperature of action will make great variations in the result obtained. The proof of this statement will be found in a reprint sent herewith. Is it not time to seek a method (or modification of an existing method) which shall meet the general approval of chemists, and be free from this radical source of error? Correspondence is respectfully invited.

Office of State Chemist, Purdue University,
Lafayette, Ind., December 1, 1883.

*Influence of Time in Fertiliser Analyses.**

By Robert B. Warder.

Mr. H. A. Huston has examined the "influence of time and temperature on the amount of phosphoric acid dissolved from commercial fertilisers by citrate of ammonium."† From a sample of raw bone fertiliser containing 20·28 per cent P_2O_5, ammonium citrate solution of 1·09 sp. gr. at 40° C. dissolved—

In 30 minutes,	4·01	per cent	P_2O_5.	
45	,,	4·97	,,	,,
60	,,	5·92	,,	,,

Each of these values is a mean of three gravimetric determinations.

The solution was evidently incomplete. The chemical operations involved are somewhat obscure. Since a very large excess of citrate was present (about 40 mol. citrate to one of phosphate), we may apply the hypothesis that the rate of solution at each moment is proportional to the phosphoric acid still present that is capable of being so dissolved, or—

* From *Scientific Proceedings of the Ohio Mech. Inst.*, 2, 134 to 139 (1883).

† *Indiana Agricultural Report for* 1882, pp. 230 to 233.

$$\frac{-du}{dt} = au,^*$$ and

$$\log. \frac{u_0}{u} = At.$$

According to this hypothesis, the most probable value for the limit of solubility, under the conditions of the experiment, is 7·8 per cent of the raw phosphate, or 38 per cent of the total phosphoric acid. For the calculated values below, A = 0·0107.

Time.	Percentage of P_2O_5 dissolved. Observed.	Calculated.	Difference.
30 mins.	4·01 (mean)	3·91	0·10
45 ,,	4·97 ,,	5·05	0·08
60 ,,	5·92 ,,	5·86	0·06

The differences in this table are far less than those which appear in the several determinations upon which the means are based; yet this apparent agreement is no real proof of the hypothesis proposed or of the limit deduced, for which further experiments would be required. Mr. Huston very aptly emphasises the importance of a uniform scale of time and temperature for determinations of reverted phosphoric acid. Some chemists are inclined to discard the citrate method entirely as unreliable. The "reverted phosphoric acid" is very objectionable, since it implies a previous solubillty; but some test for relative present solubility is demanded by dealer and consumer. Far more concordant results can be expected if the reagent used is allowed to act until the limit is nearly reached, than if the time and temperature adopted allow but fifty or seventy-five cent of the soluble matter to be taken up. It will be seen, for example, from Mr. Huston's figures, that an error of a single minute in the time of action at 40° would result in an error of more than 0·06 per cent "reverted phosphoric acid." The "Washington method"† requires an exposure of the fertiliser to a solution of ammonium citrate at the ordinary temperature for an indefinite time (during elutriation, grinding, &c.), after which the "flask is put into a cold water-bath, the temperature is rapidly raised to 40° C., and there maintained for one half-hour." Under such conditions, great variations in the analytical results are inevitable. A summer temperature of 30° C. (according to Mr. Huston's results) effects solution about two-thirds as rapidly as at 40°; while the interval required to bring the temperature to 40° will vary greatly according to the size of the water-bath and many other conditions. As a hint toward more accurate experiments in this direction, the hypothesis and figures stated above would indicate the solution of 7·6 per cent of P_2O_5 in nine and three-quarter hours, while 7·02 per cent (or nine-tenths of the whole amount) would be dissolved in two-and-a-half-hours.

The desired uniformity of method for official analyses in the several States has not yet been secured :‡ a careful study of the dynamical phase of the problem may contribute to the selection of suitable conditions.

Electric Resistance of Rarefied Air.—Professor Edlund.—The author maintains that a vacuum is a good conductor of electricity. The obstacle to the passage of the current lies in the resistance of the electrodes, which he accordingly suppresses.—*Les Mondes*, No. 14, 1883.

* This equation is explained and discussed in the paper on "Urech's Investigation of the Speed of Inversion of Cane-sugar, *Proc. Ohio Mech. Inst.*, 1, 167 to 178 (Dec., 1882).

† *Proceedings of Convention of Agricultural Chemists*, held at Washington, D.C., July 28, 1880.

‡ The New Jersey law specifies a temperature under 38° C. (100° F.) for the solution of reverted phosphoric acid, with no limitation in regard to time. In a very interesting investigation conducted by the N. C. Agricultural Experiment Station, "the cold flasks were put into the bath warmed to 40° C., and left there forty minutes," in order to secure a "temperature of 40° C. in the contents of the flask for about thirty minutes." (See Report for 1882, p. 51.) Results so obtained may be comparable among themselves, but are likely to differ from those of other observers.

NOTES ON THE SEPARATION OF TELLURIUM AND SELENIUM FROM EACH OTHER, AND THEIR PREPARATION FROM LEAD-CHAMBER DEPOSIT.*

By MASACHIKA SHIMOSÉ,
Student of the Imperial Japanese College of Engineering, Tokio.

The deposit formed in the lead-chamber during the manufacture of sulphuric acid from volcanic sulphur—consisting of the ordinary yellow kind mixed with the red variety, *seki-riu-seki*, a variety containing tellurium and selenium—has been already described by Principal Divers and myself. The examination of this deposit has led me to observe several facts which are, I believe, new to the subject, and these, together with an account of my treatment of the deposit for its analysis and for the preparation from it of tellurium and selenium, I describe in this communication.

Preparation of Tellurium and Selenium from the Deposit.

Several accounts have been published of the treatment of seleniferous flue-dust and lead-chamber mud, and these have helped to guide me in my work; but my attention has been more especially directed towards getting the tellurium out of the mud.

The mud separated by subsidence into a red sediment and a yellow liquor, both containing tellurium and selenium.†

Treatment of the Sediment.—The sediment consisted principally of ashes and lead sulphate. The sulphuric acid present in it having been more than neutralised with sodium carbonate, the selenium was removed by digesting it with concentrated solution of potassium cyanide (Nilson) at a gentle heat for some time, and then diluting the mixture with water, and heating nearly to boiling. I have found that the solution should be used nearly cold at first, as otherwise the selenium agglutinates, and then obstinately resists the action of the cyanide. For this reason, Crookes's direction to boil with cyanide for eight hours, in separating selenium from tellurium, may be altered with advantage to the direction to digest at only a gentle heat for some time. Dilution was made before heating to boiling, in order that the tellurium should be less attacked by the cyanide. The cyanide solution having been decanted, the sediment was washed by subsidence and by filtration, which proved a tedious operation. After this treatment, it was strongly acidified with sulphuric acid, and a very little nitric acid added, by which means the tellurium dissolved, this substance being, as is well known, oxidisable by cold dilute nitric acid, and its hydroxide liable to separate out unless enough sulphuric acid be present. The sulphuric acid also kept the lead sulphate insoluble. In this way, a solution of tellurium almost, if not quite, free from selenium was obtained, and through it hydrogen sulphide was passed. The tellurium sulphide was fused with potassium cyanide, and the tellurium afterwards precipitated by a current of air from the aqueous solution of the fused mass, in the usual way. The solution of selenium in potassium cyanide, previously obtained, yielded its selenium when treated with hydrochloric acid.

Treatment of the Sediment for Tellurium only.—Selenium being but little acted upon by nitric acid in the cold, it proved very advantageous for getting tellurium to treat the sediment at once with sulphuric and nitric acids, except for the fact that filtration and settling are much more tedious in the presence of undissolved selenium than in its absence. The sulphuric acid was needed, as before, to keep the oxidised tellurium in solution, and the lead sulphate out. The quantity of nitric acid used was very small—only 100 c.c., sp. gr. 1·42, to the sediment of 4 to 5 kilos. of the mud. The sulphuric acid for the same

* Communicated by Dr. Divers.

† Chemical News, vol. xlviii., p. 283.

quantity was less than 300 c.c. The dissolution was complete in about seven days, when the solution was washed out, evaporated to expel nitric acid, diluted with water, and the tellurium with a little selenium thrown down by hydrogen sulphide. The sulphides were treated with cyanide and air in the usual way for getting tellurium free from selenium.

Treatment of the Yellow Liquor of the Mud.—The yellow liquor of the mud was a ready and more convenient source of tellurium than the sediment. The quantity of selenium in it was only two-fifths that of the tellurium. Ferric sulphate being present in some quantity, I found the use of sulphur dioxide for precipitating somewhat interfered with. The tellurium and selenium were therefore separated from the liquor by means of hydrogen sulphide, and the sulphides treated by Oppenheim's method.

Analyses of the Sediment and of the Liquor.—These hardly need special notice. I will only mention that, for analytical purposes, I began by treating the washed sediment with nitro-hydrochloric acid, thus getting into solution, together, all the tellurium, selenium, and lead. The rest of the treatment presented nothing new or important to record.

Some Evidence of the Existence of Telluro-cyanate. Incompleteness of the Separation of Tellurium from Selenium by Potassium Cyanide.

It was shown many years ago by Crookes that selenium combines with potassium cyanide to form seleno-cyanate, and that from this compound the selenium is wholly set free by hydrochloric acid. At the same time he found tellurium to be only slightly attacked by potassium cyanide in boiling solution, and that the small proportion dissolved was not precipitated on addition of hydrochloric acid. He also proved that tellurium, although it goes into combination when fused with potassium cyanide, does so, not as telluro-cyanate, but as potassium telluride, and that this compound is entirely decomposed when dissolved in water, and exposed to the air. A little tellurium, not to be precipitated by air, was found by him to be also not precipitated by hydrochloric acid. The tellurium thus left in solution by either method of working was precipitable by sulphur dioxide, and was due to dissolution of oxidised tellurium, in the form of potassium salt, having taken place.

I have observed, however, that whether pure tellurium or tellurium mixed with selenium was boiled with potassium cyanide solution,* tellurium went into solution in a form not precipitable by air (telluride), not precipitable by hot potassium hydroxide and glucose solution (oxide), but precipitable by hydrochloric acid. This dissolved tellurium behaves, therefore, in a characteristic way, just like selenium in solution as seleno-cyanate, and would thus seem to be dissolved *telluro-cyanate*, a salt supposed hitherto not to exist at all.

This form of solution of tellurium, whatever view be adopted as to its nature, affects the separation of tellurium from selenium by the cyanide process. It has been considered that the precipitate formed by adding hydrochloric acid to the cyanide solution is selenium free from tellurium, and that the after-addition to the mother-liquor, of sulphur dioxide, which precipitates a little tellurium, yields all of that substance which has gone into solution —or, in the case of previous fusion, all that has resisted the action of a current of air. But I find, in accordance with what I have stated, that some tellurium in solution precipitates with the selenium, the rest coming down by treatment with sulphur dioxide.

By means of Stolba's reaction—reduction by an alkaline solution of glucose—the oxidised tellurium in solution can be first precipitated, and then the rest by hydrochloric acid. In this connection it must be remembered that Stolba's otherwise satisfactory method of precipitating tellurium is, in the presence of cyanide, not only inapplicable in the case of selenium, but also in that of tellurium.

When precipitated, or other finely-divided, tellurium is digested with concentrated solution of potassium cyanide in the cold, some of it still goes into solution, but in this case all as oxide—none in the state precipitable by hydrochloric acid. By such a digestion in the cold, selenium may be obtained free from tellurium when precipitated afterwards by hydrochloric acid, and may also be completely separated from tellurium by a sufficiently long digestion.

Preferential Precipitation by Sulphur Dioxide of Selenium before Tellurium. A striking Phenomenon capable of being applied to the Separation of these Bodies.

In a hydrochloric acid solution of oxidised tellurium and selenium, sulphur dioxide precipitates the tellurium so completely before the selenium, that, in consequence of the marked difference in colour of the two substances, a separation of them can be effected by this reagent in a very convenient way.

There should be a considerable quantity of hydrochloric acid present, because this promotes immediate precipitation, the solution should preferably be hot, and the sulphur dioxide, in the gaseous state, should be sent steadily into it. The coming out of the black tellurium is well marked and quite sudden. Through local excess of sulphur dioxide, tellurium may be seen to appear temporarily before all selenium has been liberated, but agitation then immediately re-dissolves the black tellurium by the substitution for it of an equivalent quantity of red selenium. With a little attention at the time when nearly all the selenium has been precipitated and tellurium becomes locally visible, the reducing action may be arrested at the right moment—that is, just before the blackening—and a separation of the two elements be easily made, which, though not accurate enough for analysis, yet enables the operator to obtain both pure selenium and tellurium, with only a very little mixed precipitate of the two in between.

I can recommend this method of separation as an excellent one for the purpose of preparing these substances in the pure state from a mixture of them.

Reversed order of Precipitation of Tellurium and Selenium in Acid and Alkaline Solutions. A Lecture Experiment.

Tellurium and selenium seem peculiarly well-fitted to illustrate the influence of the chemical function of allied elements upon the order of their reducibility to the simple state. For while the less basylous selenium comes out before tellurium from acid solutions, the less chlorous tellurium comes out before selenium in alkaline solutions.

I have in the preceding section called attention to the action of sulphurous acid upon hydrochloric acid solutions, and to the much greater oxidisability of tellurium by nitric acid, and will now add as a further example of the less basylous behaviour of selenium, the action of sulphuric acid upon them. Both substances, it is well known, dissolve in this acid, and impart characteristic colours to it—olive-green and purple-red. A solution of the two together is nearly black, as an effect of complementary absorption of light. Now, a mixed solution hot enough for oxidation to proceed in it, will suddenly lose its dark colour and become selenium-green, thus showing the prior oxidation of the tellurium. Again, when a little tellurium is added to a moderately warm solution of sufficient selenious hydroxide in sulphuric acid, it immediately dissolves, but the solution appears selenium-green coloured, instead of tellurium-red, thus showing the reduction by tellurium of oxidised selenium.

Turning now to alkaline solutions of tellurous and selenious hydroxides, we can observe the opposite order of reduction by means of Stolba's sugar reaction. On heating such a solution with glucose, black tellurium first

* The cyanide I used was from Hopkin and Williams, and was found to contain 65 per cent pure cyanide.

precipitates, and after a time red selenium makes its appearance.

These experiments are quickly performed, and are, besides, visible at a distance,—at least, that with sulphurous acid and that with sugar are thus to be seen. They are, therefore, well adapted for lecture illustration. Large volumes of solutions only require a few grains of the two substances to make a good display.

Sulphuric Acid as an Oxidising Agent for Selenium and Tellurium.

Sulphuric acid is decidedly preferable to nitric acid for oxidising selenium and tellurium for analytical purposes. It must be used concentrated, hot, and in somewhat large excess. The presence of so much acid is afterwards more advantageous than otherwise for the precipitation by sulphur dioxide. During the action it serves both to dissolve the tellurium and selenium before oxidation, and to keep much of the hydroxides in solution after the oxidation. The beaker in which the acid is heated should be kept covered to prevent fuming and retain the spray of the effervescence.

The superiority of sulphuric acid lies in the circumstances that oxidation being effected upon bodies in the state of solution, instead of in the solid state, goes on more rapidly and uniformly in consequence, and that it does not extend to the formation of any telluric or selenic acid, which would need reduction afterwards by boiling hydrochloric acid.

Caution needed in the Use of Bromine for Oxidising Selenium in Analytical Work.

If bromine in solution with hydrochloric acid be employed to dissolve selenium, it must be kept always in excess in the solution. For, when this is not done, selenium monochloride forms and volatilises from the aqueous solution along with hydrochloric acid, thus causing material loss and visible escape of selenium.

From this it would appear that hydrochloric acid gives stability to selenium monochloride in the presence of water. Most chemists will be aware that sulphur treated with an acid solution of bromine or chlorine evolves a strong odour of sulphur monochloride. I say chloride, not bromide, in these cases, because there can be no doubt that the bromide decomposes with hydrochloric acid.

Tellurium is not similarly affected by deficiency of bromine, and differs, as we all know, from sulphur and selenium in not forming a monochloride.

RESEARCHES ON THE TARTRATES OF ANTIMONY.

By F. W. CLARKE and CHARLES SETH EVANS.

Although some of the double tartrates of antimony, such as the tartar emetics, have been quite elaborately studied, our knowledge of its simple tartrates has hitherto been singularly inexact and vague. According to Bergmann,* a solution of antimonious oxide in aqueous tartaric acid crystallises confusedly; while according to Dulk* it does not crystallise at all. Berzelius† and Peligot‡ both obtained large crystals, but assigned different formulæ—Berzelius without analysis, Peligot after investigation. Peligot, however, must have calculated his formula upon the basis of Sb=129, the old Berzelian determination; and his analysis, re-calculated with the modern value of Sb=120, leads to no intelligible symbol. The precipitate formed by alcohol in solutions of the crystalline tartrate was also examined by Berzelius and by Peligot; and here, again, upon incomplete analyses, different formulæ were based. In short, neither Berzelius nor Peligot studied these compounds at all thoroughly; and the subject, up to the time when we began our own experiments, was in a most confused state. Inferences were more numerous than facts, and the latter needed scrupulous re-verification. We believe that we have succeeded in shedding some light upon the nature of the substances in question; and that the results which we have obtained may form a fair basis upon which to conduct future investigations.

Antimony trioxide, as is well known, is readily soluble in aqueous tartaric acid; but the properties of the solution depend upon the relative proportions of its constituents. When the oxide is dissolved in the acid to complete saturation, the solution yields no crystals whatever, but upon evaporation dries up to a gummy amorphous mass. With less oxide and an excess of acid crystallisation becomes possible, and in every case of this kind rosettes of needles are obtained. If the acid is in slight excess crystallisation takes place with difficulty, and the smaller the proportion of the oxide the more easily the crystals form. In all cases, however, in which the crystallisation occurs, the mother-liquors are exceedingly viscous, and consequently difficult to remove; so that it is by no means easy to secure pure products for examination. Furthermore, the crystals vary in composition, as the following percentages of antimony will show:—

1. 40 grms. of Sb_2O_3 were boiled with 60 grms. tartaric acid. The solution was incomplete. The filtered liquid, evaporated to dryness, gave a product containing 27·53 per cent of antimony.

2. 35 grms. Sb_2O_3 to 60 of acid. Yielded indistinct crystals which could not be purified for analysis.

3. 30 grms. Sb_2O_3 to 60 of acid. Crystals washed and twice re-crystallised. Per cent of Sb, 18·92.

4. 20 grms. Sb_2O_3 to 60 of acid. Product re-crystallised. Several distinct lots of material gave crystals containing antimony in the following percentages:—

A	13·35		
B	15·90		
C	16·48	16·64	
D	16·18	16·21	17·16
E	17·88	18·00	

The last product was dried with extreme care and examined further. The results will be given later.

5. 15 grms. Sb_2O_3 to 60 of acid. Product re-crystallised. Per cent of Sb, 5·37. Probably a mixture.

6. 12 grms. Sb_2O_3 to 60 of acid. Per cent of antimony in crystals, 3·69 to 3·82. Probably a mixture.

The antimony was weighed as sulphide in every case, and the results indicate two things—First, the difficulty of obtaining definite products; and, second, the probable existence of a series of salts. Two of the latter were analysed, as follows:—

First.—The crystals marked 3 and the preparation 4 E of the foregoing table had all the characteristics of definite compounds. They proved to be identical, and to be closely represented by the formula $Sb(C_4H_4O_6)_3H_3.4H_2O$.

	Found.			Calculated
	3.	4 E.		
Sb	18·92	17·88	18·00	18·78
C	22·59	22·98	23·19	22·53
H	3·78	3·39	3·78	3·60
Water at 120°	11·05	10·98		11·27

In brief, this tartrate, which may fairly be called antimonio-tritartaric acid, is simply a triple molecule of tartaric acid with half its replaceable hydrogen replaced by an atom of trivalent antimony. It crystallises in rosettes of white needles, and is easily soluble in water. With carbonates it effervesces strongly, and behaves like a weak acid. Its reactions in this particular will be considered further on. With alcohol its solution yields a copious white precipitate, which, washed with alcohol and thoroughly dried over sulphuric acid, proved to be neutral antimonious tartrate, $Sb_2(C_4H_4O_6)_3.6H_2O$.

* See "Gmelin's Handbook," edition of the Cavendish Society, x., 297.

† "Lehrbuch," 5 Aufl 3, 1124.

‡ *Annales de Chim. et de Phys.*, 3 série, xx., 289.

	Found.		Calculated.
Sb	30·58	30·76	30·30
C	18·14		18·18
H	3·01		3·03
Water at 160°	13·86		13·63

This salt is easily soluble in water. In its cold solution sodium carbonate produces no turbidity, but upon heating a copious white precipitate is thrown down. This particular precipitate we did not examine more closely, but its nature may be inferred from evidence to be cited later. It undoubtedly consists either of basic mixtures or of antimonious oxide, according to the amount of sodium carbonate used and the thoroughness of the boiling.

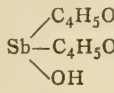
Attempts were made to prepare definite salts of antimonio-tritartaric acid, but unsuccessfully. Barium carbonate dissolves in a solution of the acid with brisk effervescence, but upon standing crystals of ordinary barium tartrate were deposited. The antimony in this case remained dissolved undoubtedly as the normal tritartrate. In another experiment a solution of the acid was rapidly neutralised with barium carbonate, and subsequently precipitated by alcohol. The copious white precipitate was washed with alcohol, air-dried, and partially analysed. So far as ascertained, its composition agrees with the formula $Sb_2(C_4H_4O_6)_3.4BaC_4H_4O_6.3H_2O$. It is probably a mixture.

	Found.		Calculated.
Sb	12·47		12·77
Ba	28·27	29·06	29·17
Water at 150°	2·45		2·87

Second.—It has already been stated that a saturated solution of antimonious oxide in tartaric acid does not crystallise. Such a solution (marked 1 in the previous table) was evaporated to dryness, and the dry product was analysed. The results were as follows:—

Sb	27·53
C	18·31
H	2·96
H_2O at 105°	10·92

This analysis is of dubious value. The compound may not have been definite, and the figures agree sharply with no probable formula. The antimony and carbon give a ratio corresponding to seven molecules of acid to four atoms of metal, and suggest the existence of a compound having the formula $Sb(OH)H_2(C_4H_4O_6)_2$. Such a formula, which may be written structurally—



is also indicated by Peligot's analysis of his "hyperacid tartrate," but it is not clearly proved. It is also further suggested by the following reaction:—

A solution containing the foregoing salt was mixed with alcohol. The usual white precipitate was washed with alcohol and air-dried over sulphuric acid. Its composition is clearly represented by the formula $Sb_2(C_4H_4O_6)_2O.6H_2O$.

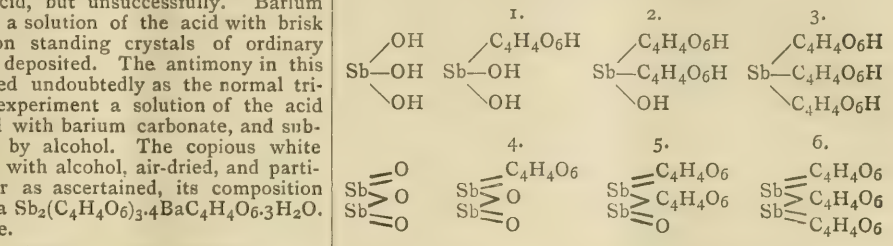
	Found.			Calculated.
Sb	36·88	36·22	36·58	36·37
C	13·56	13·90	13·56	14·54
H	2·65	2·72	2·47	3·03
H_2O at 155°	16·31	—	—	16·36

A portion of this was re-dissolved in water, and the solution was left to evaporate. No crystals formed, but the liquid dried up to a yellowish scaly mass, containing 16·39 per cent of water. Evidently no change in composition had occurred. Heated to 170° the salt lost another molecule of water, leaving two molecules of Sb $\equiv C_4H_3O_6$.

Actual loss at 170° 19·28 per cent. Theoretical, 19·09.

A similar precipitate was also examined by Peligot, who dried his product at 160° and estimated only carbon and hydrogen. From his results the formula $SbC_4H_3O_6$ has been inferred, as well as the existence of an acid salt $SbC_4H_5O_7$.* The latter compound, however, he never actually obtained; and the only evidence of its existence and properties was published from this laboratory some four years ago.†

If now we compare the formulæ of our two acid salts (using our hypothetical formula for the second) with those of the two alcoholic precipitates, certain obvious relations will appear. There ought plainly to be two series of antimony tartrates, one acid and one neutral; the first derived from ortho-antimonious acid, $Sb(OH)_3$, and the other from antimonious oxide, Sb_2O_3. The formulæ should be as follows, neglecting water of crystallisation:—



Of these, numbers 3, 5, and 6 we have actually obtained in definite condition, and number 2 we have shown to be probable. The latter is related to the neutral ditartrate just as antimonio-tritartaric acid is related to the tritartrate, and the name of antimonio-ditartaric acid may fitly be applied to it. By precipitation with alcohol it yields a neutral ditartrate, precisely as number 3 by a similar reaction yields number 6. The formula, doubled, and with five molecules of water added, is found in all reference works upon chemistry as that of Peligot's hyperacid tartrate.

The hypothetical compound numbered 1 in the foregoing schedule we did not obtain. Number 4, the monotartrate, we attempted to investigate, but with only partial success. After a number of failures, which resulted in the formation of the neutral ditartrate, we prepared a quantity of antimonious hydroxide, which we dissolved to saturation in aqueous tartaric acid. This solution yielded a precipitate with alcohol which was comparatively insoluble in water, and which, air-dried, had the subjoined composition:—

	Found.		Calculated for $Sb_2(C_4H_4O_6)O_2.2H_2O$.
Sb	53·62	53·84	52·63
C	6·43	5·38	10·52
H	1·65	1·51	1·75
H_2O at 160°	7·79		7·89

It will at once be seen that the analysis, though suggestive, is highly unsatisfactory. It merely emphasises the probability that the compound sought for exists. The white precipitate described by Berzelius had similar properties as regards insolubility, and his formula for it, translated into modern notation, agrees with ours. On the antimonyl hypothesis its formula is found in works of reference as $C_4H_4(SbO)_2O_6$. It needs, however, further investigation.

In all essential particulars the salt which we call antimonio-ditartaric acid behaves much like the corresponding tri-compound. It is strongly acid, effervesces with carbonates, and is not precipitated by alkalies in the cold. Its solution, saturated with barium carbonate and precipitated by alcohol, behaved precisely like that of the tri-acid, but the curdy white precipitate had a different composition. A partial analysis gave results agreeing with $Sb_2(C_4H_4O_6)_2O.3BaC_4H_4O_6.11H_2O$.

* Commonly written $C_4H_4H(SbO)O_6$.

† Clarke and Stallo *American Chemical Journal*, ii., 319.

	Found.		Calculated.
Sb	15·33		14·94
Ba	26·06	26·63	25·58
H_2O at 150°	12·66		12·32

This, too, is most probably a mixture, although both it and the corresponding tri-acid precipitate may be weak double compounds.

In order to get further evidence concerning the nature of the acid compounds, we neutralised a solution of the di-acid with sodium carbonate. The liquid, which remained perfectly clear, was then mixed with alcohol. At first it became turbid, and later it separated into two fluid layers, both clear, and both containing antimony. The lower layer was syrupy, and contained most of the sodium; it was accordingly drawn off, and evaporated at the ordinary temperature of the air over sulphuric acid. It slowly dried up to an amorphous gummy mass, which yielded a yellowish powder. This product we analysed. Although under the circumstances we could hardly expect a definite compound, our figures approximate to what is required by the empirical formula, $2Sb(OH)_3.3Na_2C_4H_4O_6.3H_2O$:—

	Found.		Calculated.
Sb	24·66	25·00	24·54
Na	13·48		14·11
C	15·64	15·77	14·72
H	2·62		2·45
H_2O at 150°	11·66		11·04

This compound is probably definite, although we may have failed to determine exactly the right formula. It is readily soluble in water, and very faintly acid towards litmus-paper. Its solution is stable even upon boiling, but is precipitated, when hot, by alkaline carbonates.

Another portion of the antimonio-ditartaric acid solution was exactly neutralised by sodium carbonate and boiled. A heavy precipitate fell, which we collected and dried over sulphuric acid. To the filtrate more sodium carbonate was added, and a second boiling threw down a second precipitate. Both precipitates 1 and 2 were analysed.

	I.		II.
Sb	47·87	47·28	84·25
C	3·96	4·24	—
H	3·44	3·21	—
H_2O at 155°	22·30		4·80

The second product is evidently antimonious oxide mixed with a little hydrate. The pure oxide contains 83·33 per cent of metal. The first precipitate approximates roughly to a tartrate having the formula—

$$Sb_4O_5(C_4H_4O_6).12H_2O,$$

analogous to the sulphate $Sb_4O_5(SO_4)$, the chloride $Sb_4O_5Cl_2$, &c. Doubtless such a tartrate exists, and might be prepared in a state of purity by proper precautions. It should contain 51·95 per cent Sb, 5·20 per cent C, 3·03 per cent H, 23·37 per cent H_2O. Our results, however, only indicate the probability of such a basic salt, formed by the partial precipitation of the higher tartrates, as a step in the reduction of the latter to oxide.

With the neutral* ditartrate of antimony one more suggestive experiment was tried. Its solution was cautiously mixed with dilute sulphuric acid to incipient turbidity, and then immediately precipitated by alcohol. The precipitate, which was white, contained sulphuric and tartaric acids, antimony, and water:—

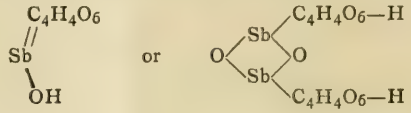
	Found.	
Sb	33·56	
SO_4	25·48	25·52
H_2O at 110°	12·31	

A compound having the formula—

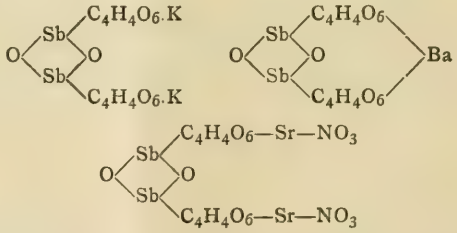
$$Sb_2(C_4H_4O_6)(SO_4)_2.7H_2O$$

would require 33·99 per cent Sb, 27·19 per cent SO_4, and 17·84 per cent H_2O. A loss of $5H_2O$ would amount to 12·75 per cent. Our figures, however, here, as in several other cases, are merely sufficient to establish a probability which may serve as a basis for future investigations. It may be regarded as practically certain that mixed salts of antimony are possible, and that sulphato-tartrates, &c., may be obtained by careful and systematic trial. Want of time precluded us from working farther in this direction.

The foregoing results, taken altogether, establish certain points pretty clearly. First, contrary to Peligot's views, antimony forms perfectly normal tartrates, in which it acts like any other trivalent metal, and in which the assumption of an antimonyl radicle, SbO, is entirely inadmissible. The other tartrates of antimony fall naturally into series, in which we sometimes find the atoms Sb and O united in accordance with Peligot's hypothesis, but not in such a way as to give the latter any validity. In all such cases the SbO group is not to be regarded as a distinct radicle, but rather as an incident in a series; a mode of union found in many other basic compounds of other metals for which no special explanation has ever been thought necessary. In the tartar emetics we have a set of salts which may or may not be interpreted on the antimonyl theory, as was shown in this laboratory some years ago, but which are best explained by regarding them as derived from a complex tartrantimonious acid to which may be assigned either af the two formulæ given below:—



The first formula was adopted in the paper from this laboratory which we previously cited, but the latter is suggested by the fact that tartar emetic, as usually written, contains only half a molecule of water, and that therefore its formula should be doubled. On this plan the tartar emetics of barium and potassium may be formulated as below, and Kessler's double salt of strontium tartar emetic and strontium nitrate becomes easily explainable also.



In the course of our present investigation we have done some work upon this class of compounds, and notably as follows:—A quantity of silver tartar emetic was dissolved in boiling water and precipitated by the addition of amyl iodide. Silver iodide was thrown down, the solution was instantly filtered, and upon cooling white brilliant crystals were deposited. These were insoluble in water, and too small for us to determine their form. Analysis gave a composition best represented by the empirical formula $2Sb_2(C_4H_4O_6)O_2.Ag_2C_4H_4O_6.3H_2O$.

	Found.		Calculated.
Sb	37·37	38·54	38·15
Ag	17·19		17·17
C	11·21	11·26	11·45
H	1·15	1·21	1·42
H_2O at 150°	3·43		4·29

Although the agreement here is very close, and the preparation of the salt, repeated several times, gave a perfectly uniform and apparently definite product, the formula cannot be regarded as certain. Our difficulty is that a

* The word "neutral" is inexact, but serves provisionally to indicate those tartrates of antimony which contain no replaceable hydrogen. Some of them are really basic.

similar experiment with ethyl iodide gave a salt of similar appearance but of different composition, as follows:—

Sb	33·37
Ag	21·61
C	11·86
H	1·16
H_2O	4·44

Possibly this preparation, which we made only once, contained unaltered silver tartar emetic. At all events, uncertainty exists, and further investigation is necessary. If the formula given above should prove to be correct it would relate the compound structurally to the salts

$$Sb_4O_5Cl_2,\ Sb_4O_5(SO_4),\ \&c.$$

In conclusion, we may describe the following new tartrantimonites:—

Aniline tartrantimonite, $SbC_4H_5O_7.C_6H_7N$, was obtained by treating the barium salt with a solution of aniline sulphate. It crystallises very easily in long white prisms, sometimes discoloured by traces of oxidation products, and has a specific gravity of 1·890 at 11°. It yielded 31·74 per cent of antimony, which is exactly the theoretical amount.

The quinine and atropine tartar emetics were prepared in a similar manner by Mr. Karl W. Langenbeck. Both salts were amorphous, yellowish, translucent masses. The quinine salt was anhydrous; the atropine salt contained two molecules of water. The analytical data are subjoined:—

Quinine Salt.	Found.	Calculated.
Sb	19·63 19·76	19·70

Atropine Salt.	Found.	Calculated.
Sb	19·88	19·67
H_2O	5·62	5·90

—*American Chemical Journal*, Vol. v., No. 4.

ON THE DETERMINATION OF THE NUMBER OF ATOMS IN MOLECULES.

By C. A. SEYLER.

The number of substances whose molecules can be determined by vapour densities is limited, and the method I have to offer may prove useful, as it is applicable to many cases of bodies which can be readily fused. In order to make it intelligible a few words on "Density" and "Specific Gravity" are necessary. The terms are often used as synonymous, but it is of importance to differentiate them. Specific gravity is the total effect of three things, molecular weight, density or intermolecular distance, and structure. Increase of molecular weight of course increases specific gravity; decrease of intermolecular distance or increase of density produces greater specific gravity, while structure decreases it. The effect of crystalline structure is often so great as to overbalance the effect of increase of density in the opposite direction. Thus the expansion of water at temperatures below 4° C. is due to the commencement of that crystalline structure which culminates in ice; and that increase of density goes an simultaneously with the expansion is supported by the observation of Arago and Fresnel that its refractive power on light continues to increase regularly as though it were growing denser (as I maintain it does).

Now from theoretical reasons I concluded in Jan., 1883, that latent heat of fusion is proportionate to the difference of density (as I define it) of the bodies in the solid and liquid states. The simplest way of calculating the density is to divide the "relative weight" (referred to hydrogen) by the molecular weight of the body. The same result may be had on a basis of Avogadro's law, but it is not necessary to state it here. If the molecular weight be unknown, the atomic weight must be used and the result indicates the density of the body *if its molecule consist only of one atom*. From data of Erman (*Ann. de Chim. et de Phys.*, xl., 209) who found the specific gravity of phosphorus just before melting to be 1·8121, and just after 1·756, I have calculated the density thus:—

P just before fusion .. .. 652·3.
P just after fusion .. .. 632·1.

The difference of these numbers is 20·2, which, *assuming the molecule of P to contain only one atom*, should (according to my theory) be the latent heat of fusion. But we know that the molecule of P contains 4 atoms, and dividing the densities by 4 we get—

163·075
158·025

The difference of these numbers is 5·05, while the latent heat of fusion is 5·034 according to Person. From data of Cavendish (*Phil. Trans.*, 1783, p. 23) and Mallet, who makes the specific gravity of mercury at its fusing-point, 14·193, I have calculated the following numbers:—

Hg just before fusion.. .. .. 792·2
Hg just after fusion .. .. .. 789·5

The difference is 2·7, while the latent heat, according to Person, is 2·8. As the theoretical number is calculated for a monatomic molecule we should expect the mercury molecule to contain only one atom, as we know to be the case. I may state my method then thus:—

The difference between the real density of a body just before and after fusion divided by the experimental latent heat gives the number of atoms in the molecule.

The density determinations are of course only useful where the body is comparatively structureless and *consequently* contracts on solidifying, but such bodies are, I believe, the rule. In crystalline bodies the density determinations will be too low, but in cases like mercury and phosphorus, where there is little crystalline structure, my rule gives closely corresponding results. If Person be right in his rule that latent heat of fusion equals the difference of absolute heat (weight × specific heat × temperature) in the solid and liquid state, then a remarkable conclusion may be drawn from my generalisation, viz., real density of a body is proportionate to its absolute temperature.

Another theory was that the density of liquids at their boiling-points should be proportionate to the latent heat of condensation. This, if true, may also help to determine the molecule of compound bodies, but I have been unable to put it properly to the test. In the following determinations the number for water is calculated from Hällström's data (*Pogg. Ann.* I., 129); the rest from rough experiments of my own:—

	Density at b.-p.	Lat. Heat.	
Water	530	535	
Oil of turpentine	71	74	
Methyl alcohol.	271	263	both impure
Ethyl alcohol .	186	202	both impure

I should be glad of any determinations of the specific gravities of bodies either before or after fusion, or of liquids at their boiling-points.

Spurious Tartar Emetic.—M. Castelhaz has in a recent circular called the attention of consumers to the sophisticated, or rather spurious, samples of antimony-potassium tartrate now in the market. This compound is used on the large scale for fastening certain coal-tar colours upon cotton, and being of course costly the attempt has been made to employ the corresponding oxalate as a substitute. The effects of this new salt both upon the fibre and upon the colours are not in all cases satisfactory, and its admixture with, or clandestine substitution for, the double tartrate is certainly a fraud. For its detection the following simple test is proposed:—A portion of the sample is dissolved in distilled water, acidified with pure acetic acid, and a solution of calcium chloride is added. If an oxalate is present a white precipitate is formed, whilst in case of a genuine double tartrate the solution remains clear.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MERCURY.

In dealing with the atomic weight of mercury we may reject the early determinations by Sefström† and a large part of the work done by Turner.‡ The latter chemist, in addition to the data which will be cited below, gives figures to represent the percentage composition of both the chlorides of mercury; but these results are neither reliable nor in proper shape to be used.

First in order we may consider the percentage composition of mercuric oxide, as established by Turner and by Erdmann and Marchand. In both investigations the oxide was decomposed by heat, and the mercury was accurately weighed. Gold leaf served to collect the last traces of mercurial vapour.

Turner gives four estimations.‖ Two represent oxide obtained by the ignition of the nitrate, and two are from commercial oxide. In the first two the oxide still contained traces of nitrate, but harly in weighable proportions. A comparison of the figures from this source with the others is sufficiently conclusive on this point. The third column represents the percentage of mercury in HgO.

144·805 grains Hg	= 11·54 grains O.		92·619 per cent.
125·980 ,,	10·08 ,,		92·592
173·561 ,,	13·82 ,,		92·625
114·294 ,,	9·101 ,,		92·620
		Mean	92·614 ± 0·0050

In the experiments of Erdmann and Marchand§ every precaution was taken to ensure accuracy. Their weighings, reduced to a vacuum standard, give the subjoined percentages :—

82·0079 grm. HgO	gave 75·9347 Hg.		92·594 per cent.
51·0320 ,,	47·2538 ,,		92·597
84·4996 ,,	78·2501 ,,		92·604
44·6283 ,,	41·3285 ,,		92·606
118·4066 ,,	109·6408 ,,		92·597
		Mean	92·5996 ± 0·0015

Combining, we have :—

Turner	92·614	± 0·0050
Erdmann and Marchand ..	92·5996	0·0015
General mean	92·601	0·0014

With a view to establishing the atomic weight of sulphur Erdmann and Marchand also made a series of analyses of pure mercuric sulphide. These data are now best available for discussion under mercury. The sulphide was mixed with pure copper and ignited; mercury distilling over and copper sulphide remaining behind. Gold leaf was used to retain traces of mercurial vapour, and the weighings were reduced to vacuum :—

34·3568 grm. HgS	gave 29·6207 Hg.		86·215 per cent Hg.
24·8278 ,,	21·40295 ,,		86·206
37·2177 ,,	32·08416 ,,		86·207
80·7641 ,,	62·6372 ,,		86·223
		Mean	86·2127 ± 0·0027

For the percentage of mercury in mercuric chloride we have data by Turner, Millon, and Svanberg. Turner,¶ in addition to some precipitations of mercuric chloride by silver nitrate, gives two experiments in which the compound was decomposed by pure stannous chloride, and the mercury thus set free was collected and weighed. The results were as follows :—

44·782 grains Hg	= 15·90 grains Cl.		73·798 per cent.
73·09 ,,	25·97 ,,		73·784
		Mean	73·791 ± 0·005

Millon* purified mercuric chloride by solution in ether and sublimation, and then subjected it to distillation with lime. The mercury was collected as in Erdmann and Marchand's experiments. Percentages of metal as follows :—

73·87
73·81
73·83
73·87
Mean 73·845 ± 0·010

Svanberg,† following the general method of Erdmann and Marchand, made three distillations of mercuric chloride with lime, and got the following results :—

12·048 grms. $HgCl_2$	gave 8·889 Hg.		73·780 per cent.
12·529 ,,	9·2456 ,,		73·794
12·6491 ,,	9·3363 ,,		73·810
		Mean	73·795 ± 0·006

Combining these series we have :—

Turner	73·791	± 0·005
Millon	73·845	0·010
Svanberg	73·795	0·006
General mean	73·798	0·0034

In this mean Turner's figures undoubtedly receive undue weight, for, on experimental grounds, they are probably inferior to both of the other series. It is better, however, that the general mean should remain as it is than that I should deal arbitrarily with any of the data.

We now have three figures to calculate from :—

Per cent of Hg in HgO ..	92·601	± 0·0014
,, HgS ..	86·2127	0·0027
,, $HgCl_2$ ..	73·798	0·0034

These give us three values for the atomic weight of mercury and a general mean as follows :—

From HgO	Hg = 199·786	±	0·059
From HgS	,, 200·016		0·088
From $HgCl_2$	,, 199·239		0·086
General mean ..	,, 199·712		0·042

If O = 16, then this becomes 200·171.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† Sefström. Berzelius's Lehrb., 5th Ed., 3, 1215. Work done in 1812.
‡ *Phil. Trans.*, 1833, 531—535.
‖ *Ibid.*, 1833, 531—535.
§ *Journ. f. Prakt. Chem.*, 31, 395; 1844.
¶ *Phil. Trans.*, 1833, 531—535.

ON THE

USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.‡

PART II.

By ROBERT T. THOMSON.

The first part of this paper was confined exclusively to the use of these indicators in the analysis of some of the more important compounds of potassium, sodium, and ammonium, and to the determination of free acids by hydrate of sodium. Since then I have devoted some at-

* *Ann. Chim. Phys.*, (3,) 18, 345. 1846.
† *Journ. f. Prakt. Chem.*, 45, 472. 1848.
‡ Read before the Chemical Section of the Glasgow Philosophical Society, December 10th, 1883.

tention to their behaviour with a few compounds of calcium, barium, and magnesium, and other substances. In this portion of the subject I have been forestalled to some extent by other chemists, who have published results which will be referred to, as they present themselves for consideration in the following paper.

I. *Application of the Indicators to the Determination of Lime existing as Hydrate, with a small proportion of Carbonate.*

For each experiment 200 c.c. of lime-water were employed, and to this was added 0·0265 grm. of carbonate of sodium, which precipitated an equivalent proportion of carbonate of calcium. This was done in a *cold* solution. The total lime (CaO) present was 0·2724, and that existing as carbonate 0·014 grm. The estimation was accomplished by half-normal hydrochloric acid, and from the result was deducted the number of c.c. required to neutralise the hydrate of sodium produced by the action of the carbonate of sodium added.

Litmus.—When this indicator was employed the test acid was added in the cold (this being the course pursued in each case) until the blue colour became purple. The solution was then boiled, and the addition of acid continued until the blue colour gave place to red, the end-reaction being very distinct. 19·4 c.c. were consumed in one experiment, and 19·5 in another, results which closely agree with the total amount of lime present. It is needless to give the results more minutely at this stage, as they will be arranged in a short table at the end of this section, along with those obtained with the other indicators.

Rosolic Acid.—The remarks made concerning litmus apply with equal weight to rosolic acid, except in the matter of colour; the latter indicator changing from deep pink to yellow. 19·4 c.c. of the acid were required in each case.

Methyl Orange.—With this indicator practically the whole of the lime was determined in the cold, no boiling being necessary, owing to the fact that the liberated carbonic acid has no effect on the colour. The results were precisely the same as those obtained with rosolic acid.

Phenacetolin.—The value of phenacetolin for the purpose under examination has been accurately estimated by Prof. Lunge, and it is therefore only for completeness sake that it is here dealt with. The method is similar to that fully described in the first part of this paper for the estimation of hydrate in presence of a little carbonate of sodium. The hydrate of calcium is first determined by adding the standard acid until the scarcely perceptible yellow colour is transformed to a distinct permanent pink, and then the proportion of carbonate of calcium is obtained by further addition of acid until the pink gives place to a deep yellow colour. For the two tests 18·4 and 18·3 c.c. were required respectively to neutralise the hydrate, while an additional 1·1 c.c. was necessary to decompose the carbonate of calcium.

It may not be out of place to remark here that my experience with phenacetolin leads me to the conclusion that it requires more skill in manipulation, when used for the determination of hydrate of potassium, sodium, or calcium, than is altogether desirable. The operator has not to deal with a sharp and unmistakable end-reaction, but is left to a certain extent in a state of indecision as to the exact point at which the pink colour, due to the action of the carbonate after neutralisation of the hydrate, shows itself. With experience, however, I have no doubt that good and concordant results are obtainable. Of course these remarks do not apply to the determination of soda or lime in the state of carbonate.

Phenolphthalein.—As was to be expected, this indicator, under favourable circumstances, behaved in the same way as in the parallel determination of the respective proportions of hydrate and carbonate of sodium. The test acid was added as carefully as possible, especially after nearly all the hydrate of calcium was neutralised, to prevent loss of carbonic acid, and when 18·9 in one experiment and 18·85 c.c. in another had been added, the red colour which had been diminishing in intensity was entirely discharged. At the same time the carbonate of calcium had passed into solution, a faint turbidity which remained being being no doubt due to the phenolphthalein. The results show that the whole of the lime existing as hydrate and half of that existing as carbonate had been estimated, thus proving that bicarbonate of calcium is neutral to phenolphthalein, just as the bicarbonates of potassium and sodium are. The solution was now boiled for a considerable time, but the red colour did not reappear, although normal carbonate of calcium was precipitated, the bicarbonate being decomposed and carbonic acid expelled. On adding excess of acid, boiling, and titrating back with caustic alkali, the whole of the lime was obtained. To verify these results, and account for the apparently anomalous behaviour of carbonate of calcium towards phenolphthalein, 0·2 grm. of the former compound freshly precipitated from a cold solution (hydrate being absent), was treated with the half-normal acid. After 4·1 c.c. had been added all the carbonate of calcium was found to be dissolved, and the red colour had disappeared. The result is equal to 0·1025 grm. of carbonate of calcium, or almost exactly half the quantity used, and this agrees with the results quoted above. On boiling, the calcium carbonate was precipitated as a hard crust on the beaker, but the colour did not return, and it now remains to enquire why this is so. Another test showed that although carbonate of calcium recently precipitated from a cold solution gives an alkaline reaction with phenolphthalein, if it is boiled no colouration is produced. At the same time the carbonate of calcium is converted from a light flocculent condition into a dense granular form, and it seems that only in the former state can the indicator penetrate into it and develop the red colour. A portion of this dense form of the compound was collected, dried, and ground finely in the agate mortar, but even then only a faint red tint was produced, which disappeared on simple boiling, or on addition of a mere trace of acid. From these facts the conclusion can be

Table I.

Showing results obtained with each indicator when used in the determination of lime as hydrate with a small proportion of carbonate of calcium.

Lime, existing as hydrate, employed	0·2584
„ „ carbonate, „	0·0140
Total lime employed	0·2724

Indicator.	Grm. of total CaO found.	Grm. of CaO as Hydrate found.		Grm. of CaO as Carbonate found.	
Litmus—					
	0·2716—0·2730	—	—	—	—
Rosolic acid—					
	0·2716—0·2716	—	—	—	—
Methyl orange—					
	0·2716—0·2716	—	—	—	—
Phenacetolin—					
	0·2730—0·2716	0·2562—	0·2576	0·0154—	0·0154
Phenolphthalein—					
	0·2716—0·2716	0·2590—	0·2576	0·0140—	0·0154

Table II.

Showing proportions of lime existing as hydrate and carbonate, respectively, in a sample of slaked lime (1) by alkalimetric method, using phenolphthalein as indicator, and (2) by the ordinary gravimetric method for determination of lime and carbonic acid.

By Alkalimetric Method.		By Gravimetric Determination of Lime and CO_2.	
Grm. CaO as Hydrate found.	Grm. CaO as Carbonate found.	Grm. CaO as Hydrate found.	Grm. CaO as Carbonate found.
0·5656	0·1134	0·5660	0·1130
0·5670	0·1141	0·5665	0·1128

safely drawn that hydrate can be determined in presence of carbonate of calcium by simply adding hydrochloric acid to a boiling solution till the red colour is gone. The lime existing as hydrate will thus be estimated, while that existing as carbonate will be left untouched.

To apply this process, a sample of slaked lime which had become carbonated to a considerable extent, and in which the total lime and carbonic acid were estimated in the ordinary way, was treated as above described. To 1 grm. of the sample a quantity of boiling water was added, the mixture boiled for a few seconds, and then titrated with half-normal acid, all the hydrate of calcium being brought into solution by agitating well after each addition. In two experiments 40·4 and 40·5 c.c. were consumed respectively, which give as an average 0·5663 grm. of lime (CaO) existing as hydrate, while the amount obtained by estimating the total lime by the ordinary gravimetric method, and subtracting that existing as carbonate, was 0·5660 grm. The carbonate of calcium was then determined by adding excess of standard acid, boiling, and titrating back with caustic soda. For this part of the process 8·1 and 8·15 c.c., respectively, of the half-normal acid were consumed, giving as an average 0·1137 grm. of lime existing as carbonate, while that calculated from the carbonic acid estimation was 0·1130 grm. Taking into consideration these results, and also those quoted above, it is not too much to say that the complete neutrality of carbonate of calcium to phenolphthalein, under the circumstances described, may be depended upon without the least hesitation.

II. *Determination of Lime existing as Carbonate.*

As the principal points in connection with this portion of the subject have already been alluded to, it will only be necessary to make one or two supplementary remarks. Litmus, rosolic acid, phenacetolin, and methyl orange can all be used with advantage for this estimation, especially when the carbonate of calcium is in the light flocculent condition. The first three of these indicators are not by any means so delicate when that compound is in a more dense form. The behaviour of phenolphthalein has already been fully discussed.

III. *Determination of Hydrate and Carbonate of Barium.*

All that has been noted with regard to litmus, rosolic acid, and methyl orange, for the determination of lime, applies with equal force to that of baryta.

Phenacetolin can be employed for the estimation of the respective proportions of baryta existing as hydrate and carbonate.

Phenolphthalein acts in the same way as it does with the calcium compounds, and may be used to find the quantity of hydrate of barium, in presence of the carbonate, the latter remaining neutral. It is noteworthy, however, that carbonate of barium, even when freshly precipitated from a cold solution, does not develop a red colour with phenolphthalein, but remains neutral. If a little colour is produced it is permanently dispelled by a mere trace of acid, or even by simple boiling.

IV. *Determination of Hydrate and Carbonate of Magnesium.*

The total magnesia existing as hydrate and carbonate can be determined by adding excess of standard sulphuric acid, boiling to dissolve perfectly and expel carbonic acid, and then titrating back with alkali. For this purpose any of the indicators may be employed. Magnesia in solution as bicarbonate can be determined directly by standard acid, in the cold with methyl orange, or in the boiling solution with any of the other indicators.

The estimation of hydrate in presence of carbonate of magnesium, using phenacetolin or phenolphthalein as indicator, is almost impossible, as the hydrate is so insoluble in water, and the limited supply of acid which requires to be added attacks it so slowly that the results are eminently unsatisfactory.

Before passing on to other compounds special attention ought to be drawn to the method recently proposed by Hehner (*Analyst*, vol. viii., page 77), for the "Estimation of Hardness without Soap Solution." By this process, which should certainly supersede the less accurate soap test for the hardness of waters, the hardness due to the carbonates of calcium and magnesium is first determined directly by standard acid in one portion of the sample. The titration must be done in a hot solution if phenacetolin, cochineal, or rosolic acid is employed as indicator, or in the cold if methyl orange is used. The author of the process recommends phenacetolin as the most delicate, and this is undoubtly the case. Having thus determined the temporary hardness, to another portion of the sample a measured quantity of standard carbonate of sodium, which must be in considerable excess, is added, and the mixture boiled till all the calcium and magnesium salts are converted into carbonate. The precipitate produced is filtered off, and the excess of carbonate of sodium determined in the filtrate by standard acid. The difference between this result and the total quantity of carbonate of sodium added is calculated to carbonate of calcium, the answer being, when brought to grains per gallon, the degrees of hardness due to salts of calcium and magnesium other than carbonate. It would be out of place to add anything to the convincing series of experiments published by Hehner, further than to state that, as the result of experiment on samples of water, I have found that the degress of hardness obtained by this simple process agree very closely with those secured by calculation from the proportions of the various compounds of calcium and magnesium determined by the ordinary gravimetric methods. One point, seldom or never referred to, is the presence of carbonate of sodium, which is not unfrequently met with in waters. When this compound is present it is obvious that the determination of temporary hardness will be high, and that in estimating the permanent hardness the amount of carbonate of sodium obtained will be greater than the quantity added. This increase calculated to carbonate of calcium, and deducted from the result at first recorded as temporary hardness, will give the true temporary hardness. And this will also represent the total hardness, as a water containing carbonate of sodium cannot contain salts of calcium or magnesium other than carbonate.

V. *Chloride, Nitrate, and Sulphate of Calcium, Barium, and Magnesium.*

These salts are neutral to all the indicators, and only in the case of methyl orange somewhat more standard acid is required to produce the full change in colour when the end reaction is reached than is necessary in solutions free from these salts. This is also true, as I had occasion to point out before, with regard to the neutral salts of potassium, sodium, and ammonium.

It has been established above that carbonate of calcium, when precipitated from a solution and boiled, is neutral to phenolphthalein. This is so decidedly the case that the amount of calcium can be determined in any neutral compound of that metal by titration with carbonate of sodium. The method of procedure is to add phenolphthalein to the solution, then neutralise with hydrate of sodium if acid, and finally add standard carbonate of sodium till the red colour at first developed is no longer discharged on boiling for a few minutes, but remains permanent. Two experiments made respectively with chloride and nitrate of calcium (each solution containing 0·096 grm. of calcium) consumed 9·6 and 9·65 c.c. of half-normal carbonate of sodium, the results being almost exactly the same as the amount of lime really present.

Similar results were obtained with barium chloride, but with magnesium salts a red colouration is produced immediately on addition of a little carbonate of sodium, and is not dispelled by prolonged boiling. The above process, therefore, cannot be used for the estimation of calcium in presence of magnesium salts, as these seem to be decom-

posed simultaneously with the calcium compounds, and produce a colouration at once.

VI. *Sulphites of Calcium and Magnesium.*

For each experiment 0·525 grm. of normal sulphite of calcium was employed, and this was prepared by mixing a quantity of solution of sulphurous acid containing 0·28 grm. of SO_2; with hydrate of calcium solution solution containing 0·245 grm. of CaO.

Litmus.—With this indicator the change in colour was very gradual, so that anything like a desirable degree of certainty could not be attained to. As about 8·5 c.c. of the half-normal hydrochloric acid were consumed it is evident that the bisulphite of calcium may be roughly regarded as the salt neutral to litmus, while the normal sulphite is strongly alkaline.

Rosolic Acid, unlike litmus, gives a sharp and well-defined end-reaction, the results of two experiments being that only a mere trace of acid was required to discharge the pink colour in a cold solution, while in a boiling solution 0·4 and 0·5 c.c. were respectively consumed. These results clearly show that normal sulphite of calcium is practically neutral to rosolic acid in a cold solution, although it shows a considerable alkaline reaction when boiling.

Methyl Orange agrees with rosolic acid in giving a delicate end-reaction, but here all likeness ceases. For the two tests 8·7 and 8·75 c.c. of half-normal acid were respectively required, which give as an average 0·1221 grm. of lime, or almost exactly half the amount really present. The bisulphite of calcium is thus neutral to methyl orange.

Phenacetolin acts in every respect like litmus, giving an exceedingly indefinite end-reaction, to bring out which about 8·5 c.c. of the standard acid was consumed.

Phenolphthalein.—The normal sulphite of calcium is neutral to this indicator, both in a cold and a boiling solution, probably being so in the latter because the sulphite of calcium is all, or nearly all, precipitated, and cannot attack the phenolphthalein.

TABLE III.

Showing results obtained in the titration of calcium sulphite with half-normal hydrochloric acid.

Amount of $CaSO_3$ employed for each test, 0·525 grm.
Equal to CaO ,, ,, 0·242 ,,

Name of Indicator.	C.c. half round acid consumed.	Grms. CaO obtained.
Litmus	8·5	0·1190
Rosolic acid (cold)	—	trace
,, (boiling)	0·4—0·5	0·0056—0·0070
Methyl orange ..	8·7—8·75	0·1218—0·1225
Phenacetolin	8·5	0·1190
Phenolphthalein (cold)	—	trace
,, (boiling)	—	—

As regards magnesium sulphite it is only necessary to remark that it acts in exactly the same way towards these indicators as calcium sulphite. A description of the experiments would be merely a repetition of what has been already related concerning the latter compound.

Leaving out of sight the results obtained with litmus and phenacetolin (these indicators being absolutely useless for all purposes connected with the accurate testing of sulphites) and looking more closely at those brought out when rosolic acid, methyl orange, and phenolphthalein were employed, it is plainly evident that a method might be constructed for the determination of sulphurous acid in a solution of that compound, or of bisulphite of lime. Such a process would obviously be based on the difference of indication shown by methyl orange on the one hand, and rosolic acid or phenolphthalein on the other, the bisulphite of calcium ($CaH_2(SO_3)_2$) being neutral to the first-mentioned indicator, while the remaining two indicate the normal sulphite ($CaSO_3$) as the neutral salt. The analogous behaviour of these three indicators with the sulphites of sodium and potassium was pointed out in the first part of this paper. To perform the titration, measure out a portion of the sample (from 20 to 50 c.c. will be convenient quantities), add methyl orange, then solution of caustic soda if acid, or hydrochloric acid if alkaline, from a burette till the neutral point is reached. Now add rosolic acid or phenolphthalein, and then normal or half-normal hydrate of sodium till the characteristic pink or red colour is just apparent. Multiply the number of c.c. consumed during the second stage of the process by 0·064 if normal alkali is used, and the answer will be the number of grms. of SO_2 in the quantity of sample operated upon. The following were results obtained in testing equal volumes of a sample of bisulphite of lime both by this and the volumetric iodine method.

TABLE IV.

Showing results obtained in testing bisulphite of lime by the alkalimetric and volumetric iodine methods respectively.

	Alkalimetric Method.		Iodine Method.
Name of Indicator.	C.c. of N/2 NaHO consumed.	Grm. of SO_2 found.	Grm. of SO_2 found.
Rosolic acid ..	14·4	0·4608	0·4590
Phenolphthalein	14·4	0·4608	0·4570

It is obvious, from the nature of the process, that sulphuric or hydrochloric acid cannot have any effect on the accuracy of the above process, as they give rise to salts neutral to rosolic acid, methyl orange, and phenolphthalein during the first addition of caustic soda. The presence of phosphoric acid, however, would be very injurious, as it would be partly counted as sulphurous acid. The only other substance likely to vitiate the results so far as to make them useless is carbonic acid, which, as has been abundantly proved, has a very great effect on rosolic acid and phenolphthalein, but more especially on the latter. The solution in this case cannot be boiled as it can in the similiar determination of phosphoric acid in phosphate of soda, after bringing it to the neutral point with methyl orange as indicator. It is therefore necessary to use a standard soda solution free from carbonate of sodium. To obtain this make up a solution of caustic soda, and determine in it the sulphate and carbonate of sodium, the former by precipitation as barium sulphate, the latter by titration with acid, using phenacetolin or phenolphthalein as indicator. Now knowing the proportion of these impurities it is only necessary to take a measured quantity of the solution of hydrate of sodium, add a quantity of chloride of barium equivalent to the carbonate and sulphate of sodium present, allow the precipitate to settle, and syphon off the clear liquor, which is then only to be tested and reduced to the required standard.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 9, November 20, 1883.

Researches on the Hyponitrites.—MM. Berthelot and Ogier.—A thermo-chemical paper which does not admit of useful abstraction.

Formation-heat of Chromic Acid.—M. Berthelot.

Researches on the Chromates.—M. Berthelot.—Chromic acid approximates to the class of acids easily separable from water like the sulphurous and carbonic, and not forming stable definite hydrates. Acetic and even

carbonic acid convert the neutral chromates into bichromates.

Alkaline Hyposulphites.—M. Berthelot.—Thermochemical papers, not capable of abridgment.

Pyrogenous Decomposition of Potassium Sulphite.—M. Berthelot.—The decomposition of this salt does not take place at 450°; it remains unaltered until raised to dull redness, and even at that temperature requires some time for complete decomposition.

Researches on Alkaline Sulphites.—M. Berthelot.—The alleged anhydrous potassium bisulphite of Muspratt, Rammelsberg, and De Marignac, instead of belonging to the same type as the other sulphites, belongs to a distinct type, the *meta-sulphites*, as different from the sulphites properly so-called as are the meta-phosphates and the pyro-phosphates from the normal phosphates.

Meta-sulphites.—M. Berthelot.—The author carries out the subject of the foregoing memoir chiefly from a thermo-chemical point of view.

Nitrogen Selenide.—MM. Berthelot and Vieille.—The explosion-heat of this dangerous substance = +42·3.

Presence of Manganese in the Zinc of Commerce, and the Means of Detecting its Traces in Zinc Ash and Calamine. Detection of Bismuth in Lead.—A. Guyard.—The zinc of commerce contains normally manganese. In zinc ash, iron, copper, and the majority of the non-volatile metals accumulate. For the detection of manganese the author dissolves zinc ash in sulphuric acid, and submits this solution to electrolysis. In a few seconds the positive pole, which should be a slip of sheet-platinum, is seen surrounded by a halo of violet permanganic acid. In like manner a small quantity of sulphuric acid is saturated with calamine, and the liquid is submitted to electrolysis even without filtration, when in a few seconds permanganic acid appears at the positive pole. The negative pole during these experiments becomes brilliantly coated with metallic zinc. When we employ as positive electrode a slip of lead, the formation of permanganic acid is easily observed, and the lead is covered with a thick coating of lead peroxide. Any bismuth which it may contain is dissolved, and is transferred to the negative electrode, where it is precipitated along with the zinc. To determine with certainty the presence of bismuth in lead, it is laminated, and used as a positive electrode in a solution of chemically pure zinc sulphate. Then the zinc deposited at the negative pole is re-dissolved in weak sulphuric acid. The blackish residue consists of bismuth and copper derived from the lead. In this state they are easily recognised chemically.

The Use of Boric Acid and Hæmatoxyline in Alkalimetry.—A. Guyard.—Already noticed.

Preparation of the Nitro-molybdic Reagent at the Maximum of Concentration.—A. Guyard.—Already noticed.

Reclamation of MM. Camille Vincent and Delachanal concerning a Process for obtaining the Sulphocarbonates, published by M. Sestini.—The authors patented, on March 3, 1881, the same process which M. Sestini describes as novel in the *Bulletin de la Société Chimique*, October 5, 1883.

No. 10, December 5, 1883.

Formation of the Double Salt in Anderson's Reaction.—Œchsner de Coninck.—The author refers to a former paper read before the *Société Chimique*, and comments on the difficulty of obtaining the salt in a state of purity.

Cosmos les Mondes.

No. 13, November 24, 1883.

Dyeing Feathers.—A short paragraph giving no novel information.

The Electro-deposition of Nickel.—H. Fontaine.—For the baths M. Gaiffe gives the following formula:—

Nickel and ammonium, double sulphate ..	1 kilo.
Distilled water	10 litres.

M. Roseleur prefers to take:—

Double sulphate	400 grms.
Ammonium carbonate	300 ,,
Distilled water	10 litres.

Each of the two salts is dissolved separately in a part of the water. The solution of ammonium carbonate is gradually poured into that of nickel, taking care not to pass the point of neutrality. The quantity of 300 grms. of ammonium carbonate indicated above is not obligatory, but may be varied according to the quality of the salt of nickel. M. Adams proposes the two following mixtures:—1. Chloride.—Take 135 grms. pure nickel, and dissolve in hydrochloric acid, avoiding excess, and heating gently. When all is dissolved, add 2·25 litres of cold water, and add gradually ammonia until the liquid is neutral to litmus paper. Dissolve separately 70 grms. sal-ammoniac in water, and mix with the former solution, and make up to 10 litres with cold water. 2. Sulphate.—Dissolve 135 grms. of pure nickel in sulphuric acid diluted with twice its weight of water, and heat until the metal is dissolved. Add water and neutralise with ammonia. Dissolve separately 70 grms. ammonium carbonate, and neutralise the solution carefully with sulphuric acid. Add this liquid to the sulphate of nickel, and make up to 10 litres with cold water. In both cases filter the liquids or dilute after standing. M. Adams ascribes a good deposit of nickel to the absence of potassa or soda, whilst in reality excellent deposits may be obtained in ammoniacal baths containing salts of potassium or sodium.

No. 14, December 1, 1883.

Modification of the Leclanché Battery.—M. Bleunard uses plates of zinc and carbon, both immersed in a saturated solution of potassium bichromate and of ammonium sulphate or hydrochlorate. To prevent the ammoniacal salts from climbing up the carbon it is previously steeped in a bath of boiling paraffin, and its surface is then scraped with a knife.

Liquid for separating Minerals of Different Specific Gravities.—The liquid is prepared by mixing 100 parts barium iodide and 130 parts mercuric iodide with 20 c.c. of distilled water, and heating to from 150° to 200° in the oil-bath, concentrating until a topaz floats upon the liquid. Its sp. gr. is 3·57.

Lavoisier and Priestley.—M. Maumené protests indignantly against the reply of Colonel W. A. Ross to Professor Rodwell.

MEETINGS FOR THE WEEK

MONDAY, Jan. 21st.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 22nd.—Royal Institution, 3. "Coins and Medals," by Mr. R. S. Foote.
—— Royal Medical and Chirurgical, 8·30.
—— Institute of Civil Engineers, 8.
WEDNESDAY, 23rd.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 24th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
FRIDAY, 25th.—Royal Institution, 8. "Kilima-njâro, the Snow-clad Mountain of Equatorial Africa," by Mr. H. H. Johnston.
—— Quekett Microscopical, 8.
SATURDAY, 26th.—Royal Institution, 3 "Life and Literature under Charles I.," by Prof. Morley.
—— Physical, 3. "On Direct Reading Electric Measuring Instruments," by Prof. Ayrton, F.R.S., and Prof. J. Perry. "On the Electromotive Force set up during Inter-diffusion," by Dr. C. R. Alder Wright, F.R.S., and Mr. C. Thompson,

THE CHEMICAL NEWS.

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THE MOLECULAR VOLUMES OF SALT SOLUTIONS.

By W. W. J. NICOL, M.A., B.Sc., F.R.S.E.,
Lecturer on Chemistry, Mason College, Birmingham.

MANY efforts have been made to establish a connection between the composition of a salt and its molecular volume; but all attempts to prove the existence of a law analogous to that of Kopp, in the case of organic liquids, have been but partially successful. This is to a great extent due to the state of molecular aggregation of the various salts not being the same, and the intermolecular spaces not being comparable but varying within comparatively wide limits: only in *strictly* isomorphous salts are the intermolecular spaces of the same magnitude.

In a paper in the *Philosophical Magazine* for August, 1883, I gave the results of various experiments on the molecular volumes of salt solutions of various strengths, and showed that in the case of the ten salts of potassium and sodium examined, the difference produced in the molecular volume of the solution by the substitution of the one metal for the other, or of one salt radical for another, was in each case a constant quantity, thus:—

$(K-Na)Cl = 10{\cdot}0$ to $10{\cdot}48$
$(K-Na)\frac{SO_4}{2} = 10{\cdot}39$ to $10{\cdot}44$
$(K-Na)NO_3 = 10{\cdot}36$
$(K-Na)ClO_3 = 10{\cdot}56$
$(K-Na)OH = 10{\cdot}06$

Also—

$K(NO_3-Cl) = 10{\cdot}98$ to $11{\cdot}4$
$Na(NO_3-Cl) = 11{\cdot}28$ to $11{\cdot}51$

$K\left(Cl-\frac{SO_4}{2}\right) = 8{\cdot}55$ to $8{\cdot}91$
$Na\left(Cl-\frac{SO_4}{2}\right) = 8{\cdot}49$ to $9{\cdot}2$

$K(ClO_3-Cl) = 18{\cdot}82$
$Na(ClO_3-Cl) = 18{\cdot}41$

"The volumes, therefore, of the above elements and groups of elements are independent of the manner in which they may be combined together provided only they be determined in solution in water and under the same conditions." Further, "When salts are dissolved in water, the molecular interspaces in various solutions are approximately co-extensive. Hence it is possible to ascertain the molecular volumes of the salts themselves with a degree of accuracy equal, at least, to that with which the molecular volumes of liquids have been determined."

I also gave an explanation of the variation (never reaching a unit) in the differences given above; this variation is due to the varying solubility of the salts, and may be proportional or not to the strength of the solutions compared.

The conclusions given above have been confirmed most strikingly by two more recent observers; the former of these—Groshaus, in a paper published in *Wiedemann's Annalen*, November, 1883—has taken the results of Kremers and others, and calculated the molecular volumes of various salt solutions; from these he subtracts the volume of water supposed to be constant, and obtains the so-called "*Reste*" (the volume of the salt in solution); this he subtracts from the molecular weight, and then he compares these figures—

$$(M\text{ wt.} - r) - (M\text{ wt.}' - r') = \Delta,$$

which is constant, just as the differences given by me are constant. He has compared *none* of the salts given by me, but his experiments leave no doubt of the *general* truth of my conclusions.

Bender (*Wiedemann's Annalen*, December, 1883) also has published a long paper with a view to prove the accuracy of the so-called *density moduli* of Favre and Palson. These moduli are numbers obtained by subtracting the densities of solutions of various salts from one another, and thus represent the change in density of a solution by the replacement of one metal by another, and so on. This is clearly the same result as I have obtained, but expressed in a different way. I may note that the results are rendered inexact to some extent by the variation of the quantity of water in the solutions compared.

Bender concludes his paper with a statement of his conviction that similar results will be obtained with organic compounds, "the radicals of which likewise will exist with constant modulus value in *any* solvent." Thus confirming most clearly my concluding words (*loc. cit.*):—

"This method of investigating the molecular volumes of salts is, in all probability, capable of extension to organic substances. . . . Such solutions need not necessarily be aqueous."

I therefore feel justified in stating the following law:—

In dilute solutions (1 equivalent to 200 H_2O) the volume of a metal in a salt is independent of the salt-radical with which it is combined, and the volume of the salt radical is independent of the metal.

I propose to more fully investigate the above points by means of the volume change in double decompositions attended by precipitation. I have already found that within narrow limits the volume change is constant in the reactions—

$$BaCl_2 + K_2SO_4 = BaSO_4 + 2KCl.$$
$$Ba(NO_3)_2 + K_2SO_4 = BaSO_4 + 2KNO_3.$$

And—

$$BaCl_2 + Na_2SO_4 = BaSO_4 + 2NaCl.$$
$$Ba(NO_3)_2 + Na_2SO_4 = BaSO_4 + 2NaNO_3.$$

In this way, too, I hope to be able to solve the much vexed question—Is water of crystallisation distinguishable from water of solution when the salt is dissolved? My experiments at present lead me to believe that it is *not*, but that *water of constitution is capable of recognition in solution.*

ON THE DETERMINATION OF THE ATOMIC WEIGHT OF OXYGEN.

By THOMAS HILDITCH.

IN all the atomic weight determinations of oxygen which have hitherto been made, hydrogen has been used which has been obtained by the solution of impure zinc in sulphuric acid, most of the impurities being removed by passing the gas over various absorbing reagents. The object of this paper is to point out some possible sources of error and to calculate the effect of these errors or impurities in the hydrogen on the result.

The most elaborate series of experiments which have as yet been made for this purpose were conducted by Dumas in conjunction with Stas* in the year 1842, and I think I shall succeed in showing that the numbers he and others† have obtained has but little weight, and also in showing the necessity of its re-determination, using methods which avoid these possible errors.

In Dumas's experiments zinc was dissolved in dilute sulphuric acid. His absorbing reagents consisted of solid silver sulphate, caustic potash, both in solution and in the solid form, a solution of lead nitrate, and, as a drying substance, either sulphuric acid or phosphorus pentoxide,

* *Compt. Rend.*, 14, 537.
† CHEMICAL NEWS, vol. xlvii., p. 275.

The impurities to be looked for in the gas as thus prepared are:—Hydrides of carbon, sulphur, antimony, and arsenic, sulphur dioxide, and carbon dioxide, oxides of nitrogen, free oxygen, nitrogen, and water; so that of these his absorbing reagents would allow to pass hydrides of carbon, nitrous and nitric oxides, and free oxygen and nitrogen. Hydrocarbons may be derived from zinc, which may possibly have contained carbon in a form similar to that contained in steel, and in which case it would be liberated as hydrocarbons on dissolving the zinc in sulphuric acid. Another possible source of hydrocarbons is from the indiarubber used in making the connections which may have retained some of the volatile hydrocarbons used in its preparation, and have given them up to the stream of hydrogen passing. The lower oxides of nitrogen would be generated by the action of hydrogen sulphide on the lead nitrate, while free oxygen and nitrogen are extremely liable to find access by diffusion through some of the indiarubber connections, or through the substance of the indiarubber itself (Graham), or even through a minute orifice or crack in some of the glass apparatus. It is noteworthy that none of the earlier experimenters appear to have applied any adequate test for the detection of either oxygen or carbon in their hydrogen, and the presence of the former is rendered the more probable by the difficulties Prof. Roscoe met with in preparing hydrogen free from this element, for use in his vanadium researches.* Another important error, but one which, though very appreciable, affects the determination only to a comparatively slight extent, is one which affects all weighings not made *in vacuo*, and is due to the power which all solid bodies appear to possess of condensing on their surfaces and gas with which they come in contact,† and is therefore greater the greater the surface exposed. In compact solids it is perhaps inappreciable, but with those in a fine state of division it may easily be estimated; but being a physical property will vary in different samples even of the same compound. A sample of copper oxide precipitated from a dilute boiling acid copper solution by a hot dilute solution of pure caustic potash I found to weigh 0·011 per cent heavier when weighed in dry air than it did when weighed *in vacuo*. This is quite independent of the error due to the displacement of the air.

Hence, in any future determination of this most important element, oxygen, the source of the hydrogen must be the electrolysis of water, rendered conducting by a suitable substance dissolved in it. Oxygen, always liable to find entrance by diffusion, may be removed by Prof. Roscoe's method by passing the gas through a hot tube containing spongy platinum, and afterwards drying the gas by means of sulphuric acid or of phosphorus pentoxide.

In these calculations 16 is assumed as the true atomic weight of oxygen, and a positive error of 0·01 means that the atomic weight will appear to be 16·01 instead of 16·00, and a negative error is to be taken the other way.

The presence of 0 0006 per cent C. in the zinc, and that equals 0·02 per cent by weight in the hydrogen, supposing it to be completely evolved as a volatile hydrocarbon on the solution of the metal in acid, and then to be completely burnt to CO_2, would cause a positive error of 0·01.

The presence of 0·111 per cent oxygen by weight, or of 0·007 per cent by volume, causes a negative error of 0·01. If oxides of nitrogen be present, then part of the nitrogen is reduced to ammonia, thereby further increasing the negative error. Free nitrogen appears to be unacted on under the conditions of this experiment.

For the third error, if the sample of copper oxide used should condense 0·006 per cent of its weight of air, this causes a positive error of 0·01 if the copper oxide is weighed in air and the reduced copper *in vacuo*; but if the oxide of copper is weighed *in vacuo* while the reduced copper is weighed in air an error of 0·008 per cent in the weighing of the copper causes a negative error in the atomic weight of 0·01. Since part of the phosphorus pentoxide used to absorb the water will deliquesce during the experiment and will then offer less surface for condensation, a slight positive error arises which it is impossible to calculate.

Sir Joseph Whitworth and Co., Limited,
Manchester, Jan. 9, 1884.

* Roscoe. *Phil. Trans.*, 1868 and 1869.
† Roscoe and Schorlemmer's "Treatise on Chemistry," vol. i., p. 594.

ON THE

USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.*

PART II.

By ROBERT T. THOMSON.

(Concluded from p. 35).

VII. *Borates of Calcium, Magnesium, Potassium, and Ammonium.*

In the former portion of this paper it was shown that the whole of the soda could be estimated in borax by standard acid, for which purpose methyl orange alone was perfect, or indeed admissible. To acertain if the borates of calcium would yield corresponding results, 2 grms. of pure boric acid were dissolved in water, and a quantity of solution of calcium hydrate containing 0·1370 grm. of lime added. The solution of borate of calcium containing excess of boric acid thus obtained was then titrated with half-normal acid, of which 9·8 c.c. were consumed in two experiments, giving 0·1372 grm. of lime in each case.

Similar tests were made with the borates of magnesium, potassium, and ammonium, and in each compound the whole of the base was estimated with as great accuracy as in the borates of sodium and calcium.

It will now be evident that any of these borates may be determined by standard acid in samples of boric acid. Even the very smallest proportion of a borate can thus be detected. Methyl orange will also be found useful in the analyses of commercial borates of lime and boracite, but in titrating these it may be found necessary, in order to get them perfectly into solution, to add excess of the standard acid, then heat till dissolved, allow to cool, and titrate back with standard hydrate or carbonate of sodium.

VIII. *Phosphates of Calcium.*

The tricalcium orthophosphate (Ca_32PO_4) being insoluble in water has no effect on any of the indicators, while the monocalcium compound (CaH_42PO_4) is neutral (as will be demonstrated immediately) to methyl orange, but is strongly acid to litmus, rosolic acid, phenacetolin, and phenolphthalein. It would seem feasible, if a suitable indicator could be obtained (and this we have in phenolphthalein) to determine phosphoric acid in a solution containing the monocalcium phosphate with excess of a neutral calcium salt present, by adding standard hydrate of sodium to the boiling solution till all the tribasic calcium phosphate was precipitated. In any attempts I have met with to accomplish this object, the separation of the lime is insisted on as necessary on the ground that ordinary superphosphates contain sulphate of calcium, which would be decomposed by the carbonate of sodium employed for titration, and give high results. Now this difficulty can be overcome by employing hydrate of sodium free from carbonate, but unfortunately another and insuperable difficulty renders such a process useless. This is shown by the following experiments:—A solution was prepared by dissolving a weighed quantity of pure tricalcium phosphate in hydrochloric acid, diluting, and adding caustic soda till the solution, which had been

* Read before the Chemical Section of the Glasgow Philosophica Society, December 10th, 1883.

coloured pink with methyl orange, was rendered distinctly yellow. The mixture was then made up to a certain volume, so that 50 c.c., the quantity used for each test, contained phosphoric acid and calcium exactly equivalent to 0·62 grm. of Ca_32PO_4. After addition of phenolphthalein half-normal caustic soda (1 c.c. of which will, under the circumstances, be equal to 0·03875 grm. of Ca_32PO_4) was added, the first two drops producing a faint but distinct precipitate, until after boiling well, a permanent red colour was produced, showing that all the phosphate of calcium was precipitated. Other tests were made with the same quantity of phosphate solution to which had been added various proportions of pure calcium chloride. The following were the results :—

0·6200	grm.	Ca_32PO_4	really present.			
0·6225	,,	,,	obtained without addition of $CaCl_2$.			
0·6400	,,	,,	,,	after adding	0·055	grm. $CaCl_2$.
0·6614	,,	,,	,,	,,	0·111	,,
0·6750	,,	,,	,,	,,	0·555	,,

These results show that a basic phosphate must be to some extent produced, the amount being greater when the proportion of neutral calcium salt present is greater, although even in the experiment made with the smallest quantity of calcium chloride, the most part of that compound remained in solution after the titration was finished. By the first of these tests, that made with the pure phosphate solution without addition of calcium chloride, it is proved that the monocalcium phosphate (CaH_42PO_4) is neutral to methyl orange, because if it were not so, the result would have been either high or low, whereas it is at least within the limits of error. In corroboration of thls, it has been already noted that the neutral point obtained by the use of methyl orange comes very close to that shown by the ordinary method of adding alkali till a faint precipitate appears. As would be expected the methyl orange indicates neutrality just before any precipitate is produced, and to verify the fact several additional tests were made. It may be worthy of a passing note to mention that when the titration described above is accomplished in the cold, much less of the alkali is consumed, the whole of the phosphoric acid is precipitated, but a considerable portion of the lime remains in solution. On boiling, the colour is dispelled, and the same results as those quoted above are obtained.

Having now discovered sufficiently grave reasons to discard the process described above, is will be well to examine the "New Method for the Volumetric Determination of Phosphoric Acid in the Superphosphates" proposed by A. Mollenda (Chemical News, vol. xlvii., page 231). This process consists in adding an alkali to the solution in which the phosphoric acid is to be determined, until a faint precipitate appears, then precipitating the lime in a boiling solution with oxalate of sodium, filtering off the oxalate of calcium, and titrating the filtrate, which now contains the monosodium phosphate (NaH_2PO_4) with hydrate or carbonate of sodium, using litmus, phenacetolin, or phenolphthalein as indicator. The author of the article prefers the latter indicator, and in that case caustic soda or potash must be used. In the first part of this paper I proposed a similar method for the determination of phosphoric acid in phosphate of sodium, which depended on the difference of indication shown by methyl orange and phenolphthalein, but in this case the former indicator cannot be employed after precipitation of lime, as oxalate of sodium acts like an alkali toward it. It may be used in the neutralisation before precipitating the lime, instead of depending on the less exact appearance of a faint precipitate. In two determinations made with 0·62 grm. of pure tricalcium phosphate by Mollenda's method thus modified, 7·9 and 7·95 c.c. of half-normal caustic soda were consumed respectively. As the equivalent of 1 c.c. in Ca_32PO_4 is 0·0775 grm., the amounts thus brought out gave as an average 0·6142 grm. These quantities are decidedly too low, but the difference may be accounted for partly through a little of the phosphate being precipitated along with the oxalate of calcium, but must be chiefly assigned to the slight alkalinity of disodium phosphate (Na_2HPO_4), produced by the action of the sodium hydrate. An allowance, based on tests made with pure disodium phosphate, of 100th part of the whole phosphate present will eliminate the error thus caused. With regard to the use of litmus or phenacetolin in place of phenolphthalein, I can only repeat what was noted formerly, that not only are the neutral points indicated by the two former entirely different from the latter, but the end-reactions are so uncertain as to render them useless where anything approaching to trustworthy results are required.

A few experiments were next devoted to the estimation of phosphate of calcium in presence of iron. The solution employed contained 0·62 grm. of phosphate of calcium and perchloride of iron equivalent to 0·006 grm. of ferric oxide. Carrying out Mollenda's process *unmodified* (that is, utilising the production of the faint precipitate to indicate the neutral point) three experiments gave 0·7002 and one test gave 0·7020 grm. of Ca_32PO_4. These results are so extremely high that they would give a difference of 3 or 4 per cent in an ordinary superphosphate of average strength. The results were the same when the preliminary neutralisation was done in a boiling solution. More alkali was required to effect the preliminary neutralisation when methyl orange was employed, and at the same time a considerable precipitate was produced. The precipitate was collected, and on applying the necessary tests proved to be pure phosphate of iron. It weighed 7 milligrms., and thus contained about two-thirds of the total iron present. The filtrate was then treated with sodium oxalate, and titrated with half-normal caustic soda, and on adding the weight of the ferric phosphate precipitate, the total amount agreed with those obtained from pure tricalcium phosphate.

A small quantity of aluminium was found to have the same effect as iron, and it is evident that these two metals must be removed, as otherwise, even if they remain in solution, correct results cannot be expected. These results show that, in constructing a method of chemical analysis, every possible, and even what may with some show of reason be considered impossible, source of error must be taken into account, and the subject carefully worked out.

The accuracy of the process does not seem to be affected by neutral magnesium salts, but it cannot be applied directly to superphosphates containing ammonium salts, as these injure the delicacy of the phenolphthalein. On the whole no more can be said in favour of this method than that, under suitable circumstances, it will give a near approximation to the truth.

IX. *Behaviour of the Indicators with Carbolic Acid, &c.*

Having had occasion to test directly the alkalinity of a certain ammonia liquor, among other indicators I used rosolic acid, and found the pink colour at first developed was quickly destroyed, and could not be brought back with caustic soda. This led to testing the action of carbolic acid, with the result that that body was found to be neutral to litmus, rosolic acid, methyl orange, and phenacetolin, and that none of these was destroyed even after prolonged contact. Two grms. of pure phenol dissolved in water and phenolphthalein added, required 1·2 c.c. of half-normal alkali to produce a faint red colouration, but a considerable additional quantity was required to bring out the full intensity of colour. The result shows that 100 parts of phenol require 0·63 grm. of soda (Na_2O) to make it neutral to phenolphthalein, but the end-reaction is extremely indistinct.

On another occasion I wished to determine the soda in a solution of sodium sulphide prepared by passing sulphuretted hydrogen through caustic soda, and found that, on adding acid in excess, the methyl orange employed seemed to have been destroyed and gave no pink colour. There was a little sulphur precipitated, and thinking that it might have some reducing action, I made a test

TABLE OF THE BEHAVIOUR OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS IN THE DETERMINATION OF ALKALI BY STANDARD ACIDS, AND OF ACIDS BY STANDARD ALKALI.

In the following table are given the parts by weight of base or acid which can be estimated by standard acid or alkali in the various compounds, when 100 parts of the base or acid are present. The figures relating to the fats and fatty and resin acids are given on the authority of Hehner and Allen. When the end-reaction is noted as "uncertain," it must be understood that the indicator is practically useless, unless specified otherwise in a note.

Compounds Titrated.	Condition of Solution.	Per cent of Base Estimated with				
		Litmus.	Rosolic Acid.	Methyl Orange.	Phenacetolin.	Phenolphthalein.
KHO, NaHO, $Ca(HO)_2$, $Ba(HO)_2$	Cold	100	100	100	100	100
	Boiling	100	100	100	100	100
	End-reaction	delicate	delicate	delicate	delicate	delicate
NH_4HO	Cold	100	100	100	100	97
	End-reaction	delicate	delicate	delicate	delicate	uncertain
K_2CO_3, Na_2CO_3	Cold	—	—	100	—	50*
	Boiling	100	100	—	100	100
	End-reaction					uncertn (cold) delicate (hot)
$(NH_4)_2CO_3$	Cold	—	—	100	— †	cannot be
	End-reaction	—	—	delicate	—	used at all
$CaCO_3$, $BaCO_3$	Cold	—	—	100	—	0‡
	Boiling	100	100	—	100	0
	End-reaction	delicate	delicate	delicate	delicate	—
$NaHCO_3$, $KHCO_3$, $CaH_2(CO_3)_2$	Cold	—	—	100	—	0
	Boiling	100	100	—	100	100‖
	End-reaction	delicate	delicate	delicate	delicate	delicate (hot)
MgO, $MgCO_3$	Cold	—	—	100	—	—
	Boiling	100	100	—	100	100
	End-reaction	delicate	delicate	delicate	delicate	delicate
Na_2SO_3, K_2SO_3	Cold	about 50	0·4	50	about 50	0·4
	Boiling	—	10·2	—	—	8·0
	End-reaction	uncertain	delicate	delicate	uncertain	delicate
$(NH_4)_2SO_3$	Cold	about 50	0·4	50	about 50	cannot be
	End-reaction	uncertain	delicate	delicate	uncertain	used
$CaSO_3$, $MgSO_3$	Cold	about 50	0·4	50	about 50	0·4
	End-reaction	uncertain	delicate	delicate	uncertain	delicate
Na_2S, K_2S	Cold	—	—	100	—	50
	Boiling	100	100	—	100	100
	End-reaction	delicate	delicate	delicate	delicate	uncertn (cold) delicate (hot)
$(NH_4)_2S$	Cold	—	—	100	— §	cannot be
	End-reaction	—	—	delicate	—	used
Na_2HPO_4, K_2HPO_4	Cold	about 50	about 50	50	about 50	1·0
	Boiling	about 50	about 50	—	about 50	5·5
	End-reaction	uncertain	uncertain	delicate	uncertain	delicate
$(NH_4)_2HPO_4$	Cold	about 50	about 50	50	about 50	cannot be
	End-reaction	uncertain	uncertain	delicate	uncertain	used
NaH_2PO_4, KH_2PO_4, $CaH_4(PO_4)_2$	—	acid	acid	neutral	acid	acid
	End-reaction	—	—	delicate	—	—
Silicates of Na and K	Cold	100	—	100	100	88
	Boiling	100	100	—	100	90
	End-reaction	delicate	delicate	delicate	delicate	uncertain
Borates of Na, K, NH_4, Ca, and Mg	Cold	100	100	100	100	46¶
	Boiling	100	100	—	100	67
	End-reaction	uncertain	uncertain	delicate	uncertain	uncertain

Table (*continued*).

Compounds Titrated.	Condition of Solution.	Per cent of Base Estimated with: Litmus.	Rosolic Acid.	Methyl Orange.	Phenacetolin.	Phenolphthalein.
Al_2O_3 (freshly precipitated)	Cold	--	—	about 100	0	0
	Boiling	1	1	—	0	0
	End-reaction	delicate	delicate	uncertain**	delicate	delicate
		Per cent of Acid Estimated with: Litmus.	Rosolic Acid.	Methyl-Orange.	Phenacetolin.	Phenolphthalein.
H_2SO_4, HCl, HNO_3	Cold	100	100	100	100	100
	End-reaction	delicate	delicate	delicate	delicate	delicate
$H_2C_2O_4$	Cold	100	100	90	100	100
	End-reaction	delicate	delicate	uncertain	uncertain	delicate
$HC_2H_3O_2$	Cold	99·8 ††	100	12	96	100
	End-reaction	uncertain	uncertain	uncertain	uncertain	delicate
$H_2C_4H_4O_6$	Cold	100	100	80	99	100
	End-reaction	somewhat indistinct	somewhat indistinct	uncertain	uncertain	delicate
$H_3C_6H_5O_7$	Cold	98·5 ††	99	45	86	100
	End-reaction	uncertain	uncertain	uncertain	uncertain	delicate
Phenol	Cold	neutral	neutral	neutral	neutral	100 grms. phenol consumes 0·63 grm. Na_2O
	End-reaction	delicate	delicate	delicate	delicate	uncertain

Fatty and resin acids and neutral fats. The following substances can be determined by standard alcoholic potash, with phenolphthalein as indicator. One c.c. normal caustic potash (1 c.c. = 0·056 grm. KHO) is equal to:—

0·088	gramme butyric acid	0·1007	gramme tributyrin
0·282	,, oleic ,,	0·2947	,, triolein
0·256	,, palmitic ,,	0·2687	,, tripalmitin
0·284	,, stearic ,,	0·2967	,, tristearin
0·410	,, cerotic ,,	0·676	,, myricin
0·329	,, resin acids (ordinary colophony, chiefly sylvic acid).		

* The end-reaction is distinct when only small quantities (say not more than 0·1 grm.) of the carbonate are present.

† Litmus, rosolic acid, or phenacetolin can be used if excess of acid is added, the solution boiled, and titrated back with alkali.

‡ 50 per cent is estimated if $CaCO_3$ (but not $BaCO_3$) is freshly precipitated, but not after boiling.

‖ This only applies to the sodium and potassium salts.

§ See Note †.

¶ This does not apply to ammonium borates.

** End-reaction is tolerably distinct when only small quantites of Al_2O_3 are present.

†† The standard NaHO used was standardised with normal H_2SO_4.

with a mixture of sulphite and thiosulphate of sodium, but the precipitated sulphur did not hinder the pink colour from appearing and remaining permanent. I have not yet had time to experiment further in the direction of solving these problems connected with rosolic acid and methyl orange.

In the Table is given an epitome of the results obtained in the first and second parts of this paper, including a few results recorded by other chemists.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending December 31st, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, January 6th, 1884.

Sir,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from December 1st to December 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 168 samples of water, the whole were, without exception, clear, bright, and well filtered.

Altogether, the condition of the metropolitan water during the past month, in respect to aëration and freedom from colour and turbidity, has been unexceptionable. In one sample only out of those completely analysed was the amount of organic carbon at all excessive; while the mean proportion was low—and unusually low for the period of the year. This exceptional lowness in the amount of organic carbon, and consequently organic matter, was doubtless dependent on the exceptional character of the

season, and more particularly on the mildness of the temperature, and the absence of river floods.

We are, Sir,

Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

CHROMIUM.

Concerning the atomic weight of chromium there has been much discussion, and many experimenters have sought to establish the true value. The earliest work upon it having any importance was that of Berzelius,† in 1818 and 1826, which led to results much in excess of the correct figure. His method consisted in precipitating a known weight of lead nitrate with an alkaline chromate, and weighing the lead chromate thus produced. The error in his determination arose from the fact that lead chromate, except when thrown down from very dilute solutions, carries with it minute quantities of alkaline salts, and so has its apparent weight notably increased. When dilute solutions are used, a trace of the precipitate remains dissolved, and the weight obtained is too low. In neither case is the method trustworthy.

In 1844 Berzelius's results were first seriously called in question. The figure for chromium deduced from his experiments was somewhat over 56; but Peligot‡ now showed, by his analyses of chromous acetate and of the chlorides of chromium, that the true number was near 52·5. Unfortunately, Peligot's work, although good, was published with insufficient details to be useful here. For chromous acetate he gives the percentages of carbon and hydrogen, but not the actual weights of salt, carbon dioxide, and water from which they were calculated. His figures vary considerably moreover, enough to show that their mean would carry but little weight when combined with the more explicit data furnished by other chemists.

Jacquelain's‖ work we may omit entirely. He gives an atomic weight for chromium which is notoriously too low, and prints none of the numerical details upon which his result rests. The researches which particularly command our attention are those of Berlin, Moberg, Lefort, Wildenstein, Kessler, and Siewert.

Among the papers upon the atomic weight under consideration that by Berlin is one of the most important.§ His starting point was normal silver chromate; but in one experiment the anhydrochromate $Ag_2Cr_2O_7$ was used. These salts, which are easily obtained in a perfectly pure condition, were reduced in a large flask by means of hydrochloric acid and alcohol. The chloride of silver thus formed was washed by decantation, dried, fused, and weighed without transfer. The united washings were supersaturated with ammonia, evaporated to dryness, and the residue treated with hot water. The resulting chromic oxide was then collected upon a filter, dried, ignited, and weighed. The results were as follows:—

Grms.		Grms.		Grms.	
4·6680	Ag_2CrO_4 gave	4·027	AgCl and	1·0754	Cr_2O_3.
3·4568	,,	2·983	,,	0·7960	,,
2·5060	,,	2·1605	,,	0·5770	,,
2·1530	,,	1·8555	,,	0·4945	,,
4·3335	$Ag_2Cr_2O_7$ gave	2·8692	,,	1·5300	,,

From these weighings three values are calculable for the atomic weight of chromium. The three ratios upon which these values depend we will consider seperately; taking first that between the chromic oxide and the original silver salt. In the four analyses of the normal chromate the percentages of Cr_2O_3 deducible from Berlin's weighings are as follows:—

23·037
23·027
23·025
22·968

Mean 23·014 ± 0·011

And from the single experiment with $Ag_2Cr_2O_7$ the percentage of Cr_2O_3 was 35·306.

For the ratio between Ag_2CrO_4 and AgCl, putting the latter at 100, we have for the former:—

115·917
115·883
115·992
116·033

Mean 115·956 ± 0·023

In the single experiment with anhydrochromate 100 AgCl is formed from 151·035 $Ag_2Cr_2O_7$.

Finally, for the ratio between AgCl and Cr_2O_3, the five experiments of Berlin give, for 100 parts of the former, the following quantities of the latter:—

26·705
26·685
26·707
26·650
26·662

Mean 26 682 ± 0·0076

These results will be discussed in connection with the work of other investigators at the end of this chapter.

In 1848 the researches of Moberg* appeared. His method simply consisted in the ignition of anhydrous chromic sulphate and of ammoniacal chrome alum, and the determination of the amount of chromic oxide thus left as residue. In the sulphate, $Cr_2(SO_4)_3$, the subjoined percentages of Cr_2O_3 were found. The brackets indicate two different samples of material, to which, however, we are justified in ascribing equal value:—

0·542 grm. sulphate	gave	0·212	Cr_2O_3.	39·114	per cent.
1·337	,,	0·523	,,	39·117	,,
0·5287	,,	0·207	,,	39·153	,,
1·033	,,	0·406	,,	39·303	,,
0·868	,,	0·341	,,	39·286	,,

Mean 39·1946 ± 0·0280

From the alum, $(NH_4)_2Cr_2(SO_4)_2.24H_2O$, we have these percentages of Cr_2O_3. The first series represents a salt long dried under a bell-jar at a temperature of 18°. The crystals taken were clear and transparent, but may possibly have lost traces of water,† which would tend to increase the atomic weight found for chromium. In the second series the salt was carefully dried between folds of filter-paper, and results were obtained quite near those of Berlin. Both of these series are discussed together, neither having a remarkable value:—(See next Table).

The determinations made by Lefort‡ are even less valuable than those by Moberg. This chemist started out from pure barium chromate, which, to thoroughly free it from moisture, had been dried for several hours at 250°. The chromate was dissolved in pure nitric acid, the

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* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Schweigg, Journ.*, 22, 53, and *Poggend. Annal.*, 8, 22.

‡ *Compt. Rend.*, 19, 609 and 734; 20, 1187; 21, 74.

‖ *Compt. Rend.*, 24, 679. 1847.

§ *Journ. f. Prakt. Chem.*, 37, 509, and 38, 149. 1846.

* *Journ. f. Prakt. Chem.*, 43, 114.

† This objection is suggested by Berlin in a short note upon Lefort's paper. *Journ. f. Prakt. Chem.*, 71, 191.

‡ *Journ. f. Prakt. Chem.*, 51, 261. 1850.

1·3185	grm. alum gave	0·213	Cr_2O_3.	16·155 per cent.
0·7987	,,	0·129	,,	16·151 ,,
1·0185	,,	0·1645	,,	16·151 ,,
1·0206	,,	0·1650	,,	16·167 ,,
0·8765	,,	0·1420	,,	16·201 ,,
0·7680	,,	0·1242	,,	16·172 ,,
1·6720	,,	0·2707	,,	16·190 ,,
0·5410	,,	0·0875	,,	16·174 ,,
1·2010	,,	0·1940	,,	16·153 ,,
1·0010	,,	0·1620	,,	16·184 ,,
0·7715	,,	0·1235	,,	16·007 ,,
1·374	,,	0·2200	,,	16·012 ,,

Mean 16·143 ± 0·0125

barium thrown down by sulphuric acid, and the precipitate collected upon a filter, dried, ignited, and weighed in the usual manner. The natural objection to the process is that traces of chromium may be carried down with the sulphate, thus increasing its weight. In fact, Lefort's results are somewhat too high. Calculated from his weighings, 100 parts of $BaSO_4$ correspond to the amounts of $BaCrO_4$ given in the third column:—

1·2615	grms. $BaCrO_4$ gave	1·1555	grms. $BaSO_4$.	109·174
1·5895	,,	1·4580	,,	109·019
2·3255	,,	2·1340	,,	108·974
3·0390	,,	2·7855	,,	109·101
2·3480	,,	2·1590	,,	108·754
1·4230	,,	1·3060	,,	108·708
1·1975	,,	1·1005	,,	108·814
3·4580	,,	3·1690	,,	109·119
2·0130	,,	1·8430	,,	109·224
3·5570	,,	3·2710	,,	108·744
1·6470	,,	1·5060	,,	109·363
1·8240	,,	1·6725	,,	109·058
1·6950	,,	1·5560	,,	108 933
2·5960	,,	2·3870	,,	108·756

Mean 108·9815 ± 0·0369

Wildenstein,* in 1853, also made barium chromate the basis of his researches. A known weight of pure barium chloride was precipitated by a neutral alkaline chromate, and the precipitate allowed to settle until the supernatant liquid was perfectly clear. The barium chromate was then collected on a filter, washed with hot water, dried, gently ignited, and weighed. Here again arises the objection that the precipitate may have retained traces of alkaline salts, and again we find deduced an atomic weight which is too high. 100 parts $BaCrO4$ correspond to $BaCl_2$ as follows:—

81·87	81·57
81·80	81·75
81·61	81·66
81·78	81·83
81·52	81·66
81·84	81·80
81·85	81·66
81·70	81·85
81·68	81·57
81·54	81 83
81·66	81·71
81·55	81·63
81·81	81·56
81·86	81·58
81·54	81·67
81·68	81·84

Mean 81·702 ± 0·014

Next in order we have to consider two papers by Kessler, who employed a peculiar volumetric method entirely his own. In brief, he compared the oxidising power of potassium anhydrochromate with that of the chlorate, and from his observations deduced the ratio between the molecular weights of the two salts.

In his earlier paper* the mode of procedure was about as follows:—The two salts, weighed out in quantities having approximate chemical equivalency, were placed in two small flasks, and to each was added 100 c.c. of a ferrous chloride solution and 30 c.c. hydrochloric acid. The ferrous chloride was added in trifling excess, and, when action ceased, the amount unoxidised was determined by titration with a standard solution of anhydrochromate. As in each case the quantity of ferrous chloride was the same, it became easy to deduce from the data thus obtained the ratio in question. I have reduced all of his somewhat complicated figures to a simple common standard, and give below the amount of chromate equivalent to 100 of chlorate:—

120·118
120·371
120·138
120·096
120·241
120·181

Mean 120·191 ± 0·028

In his later paper† Kessler substituted arsenic trioxide for the iron solution. In one series of experiments the quantity of anhydrochromate needed to oxidise 100 parts of the arsenic trioxide was determined, and in another the latter substance was similarly compared with the chlorate. The subjoined columns give the quantity of each salt proportional to 100 of As_2O_3:—

$K_2Cr_2O_7$.	$KClO_3$.
98·95	41·156
98·94	41·116
99·17	41·200
98·98	41·255
99·08	41·201
99·15	41·086
	41·199
Mean 99·045 ± 0·028	41·224
	41·161
	41·193
	41·149
	41·126

Mean 41·172 ± 0·009

From the data given in the earlier paper, if we use our recent values for chlorine, potassium, and oxygen,

		$K_2Cr_2O_7$ = 293·937	± 0·086
And from the latter,	,,	294·159	0·119
General mean	,,	294·013	0·0697

Finally, we come to the determinations published by Siewert,‡ whose work does not seem to have attracted general attention. He, reviewing Berlin's work, found that upon reducing silver chromate with hydrochloric acid and alcohol, the chromic chloride solution always retained traces of silver chloride dissolved in it. These could be precipitated by dilution with water; but, in Berlin's process, they naturally came down with the chromium hydroxide, making the weight of the latter too high. Hence too large a value for the atomic weight of chromium. In order to find a more correct value Siewert resorted to the analysis of sublimed, violet, chromic chloride. This salt he fused with sodium carbonate and a little nitre, treated the fused mass with water, and precipitated from the resulting solution the chlorine by silver nitrate in presence of nitric acid. The weight of the silver chloride thus obtained, estimated after the usual manner, gave means for calculating the atomic weight of chromium.

* *Journ. f. Prakt. Chem.*, 59, 27.

* *Poggend. Annal.*, 95, 208. 1855.
† *Ibid.*, 113, 137. 1861.
‡ *Zeitschrift Gesammt. Wissenschaften*, 17, 530. 1861.

His figures, reduced to a common standard, give, as proportional to 100 parts of chloride of silver, the quantities of chromic chloride stated in the third of the subjoined columns:—

0·2367 grm.	Cr_2Cl_6 gave	0·6396 grm.	AgCl	37·007
0·2946	,,	0·7994	,,	36·853
0·2593	,,	0·7039	,,	36·838
0·4935	,,	1·3395	,,	36·842
0·5850	,,	1·5884	,,	36·830
0·6511	,,	1·76681	,,	36·852
0·5503	,,	1·49391	,,	36·836

Mean $36·865 \pm 0·0158$

The first of these figures varies so widely from the others that we are justified in rejecting it; in which case the mean becomes $36·842 \pm 0·0031$.

Siewert also made two analyses of silver anhydrochromate by the following process:—The salt, dried at 120°, was dissolved in nitric acid. The silver was then thrown down by hydrochloric acid, and, in the filtrate, chromium hydroxide was precipitated by ammonia. Reduced to a uniform standard, we find from his results, corresponding to 100 parts of AgCl, $Ag_2Cr_2O_7$, as in the last column:—

$Ag_2Cr_2O_7$.		AgCl.		Cr_2O_3.	
0·7866 grm.	gave	0·52202	and	0·2764	150·684
1·089	,,	0·72249		0·3840	150·729

Mean $150·706 \pm 0·015$

Giving Berlin's single estimation equal weight with one of these, and combining, we get a general mean of $150·816 \pm 0·074$.

Siewert's percentages of Cr_2O_3, obtained from $Ag_2Cr_2O_7$, are as follows, calculated from the above weighings:—

35·139
35·262

Mean $35·2005 \pm 0·0415$

Combining, as before, with Berlin's single result, giving the latter equal weight with one of these, we have a general mean of $35·236 \pm 0·0335$.

For the ratio between silver chloride and chromic oxide, Siewert's two analyses of the anhydro-chromate come out as follows. For 100 parts of AgCl we have of Cr_2O_3:—

52·948
53·150

Mean $53·049 \pm 0·068$

This figure, reduced to the standard of Berlin's work on the mono-chromate, becomes $26·525 \pm 0·034$. Berlin's mean was $26·682 \pm 0·0076$. The two means combined give a general mean of $26·676 \pm 0·074$.

We may now consider the ratios before us, which are as follows:—

(1) Percentage Cr_2O_3 from Ag_2CrO_4, $23·014 \pm 0·011$
(2) Percentage Cr_2O_3 from $Ag_2Cr_2O_7$, $35·236 \pm 0·0335$
(3) AgCl : Ag_2CrO_4 : : 100 : $115·956 \pm 0·023$
(4) AgCl : $Ag_2Cr_2O_7$: : 100 : $150·816 \pm 0·074$
(5) AgCl : Cr_2O_3 : : 100 : $26·676 \pm 0·0074$
(6) Percentage Cr_2O_3 in chromic sulphate, $39·1946 \pm 0·0280$
(7) Percentage Cr_2O_3 in ammonia chrome alum, $16·143 \pm 0·0125$
(8) $BaSO_4$: $BaCrO_4$: : 100 : $108·9815 \pm 0·0369$
(9) $BaCrO_4$: $BaCl_2$: : 100 : $81·702 \pm 0·014$
(10) Molecular weight of $K_2Cr_2O_7$, $294·013 \pm 0·0698$
(11) AgCl : $CrCl_3$: : 100 : $36·842 \pm 0·0031$

From these ratios we can at once deduce five values for the molecular weight of Cr_2O_3, as follows:—

From (1) ..	Cr_2O_3 =	152·612	± 0·074
(2) ..	,,	151·905	0·165
(5) ..	,,	152·634	0·044
(6) ..	,,	154·464	0·135
(7) ..	,,	154·512	0·125
General mean	,,	152·855	0·034

For barium chromate we get two values:—

From (8) ..	$BaCrO_4$ =	253·494	± 0·094
(9) ..	,,	253·976	0·067
General mean	,,	253·816	0·054

From (3) we get	Ag_2CrO_4 =	331·739	± 0·070
(4) ,,	$Ag_2Cr_2O_7$	431·470	0·215
(11) ,,	$CrCl_3$	158·102	0·018

Finally, from these intermediate data we derive six values for the atomic weight of chromium:—

From $BaCrO_4$	Cr =	53·200	± 0·064
Cr_2O_3	,,	52·482	0·018
Ag_2CrO_4	,,	52·536	0·074
$Ag_2Cr_2O_7$	,,	52·188	0·109
$K_2Cr_2O_7$	,,	52·116	0·078
$CrCl_3$	,,	51 992	0·047
General mean ..	,,	52·453	0·015
Or, if O = 16 ..	,,	52·574	

On account of the wide discrepancies between different data, and of the known constant errors vitiating some of the series of experiments, the foregoing general mean can have but little real value. In fact, a careful consideration of all the work represented in it will show that the most accurate estimate of the atomic weight of chromium must be deduced from the experiments of either Berlin, Kessler, or Siewert. Berlin's figures, taken by themselves, and combined, give, if the single analysis of silver anhydrochromate be assigned equal weight with a single analysis in the mono-chromate series, $Cr = 52·389 \pm 0·019$; or, if $O = 16$, $Cr = 52·511$.

Siewert's results, both for chromic chloride and the silver anhydro-chromate, properly combined, give $Cr = 52·009 \pm 0·025$. If $O = 16$, this value becomes $Cr = 52·129$. In brief, the atomic weight of chromium may be nearly 52·5, or it may be 52. Only a revision of all the experiments could enable us to decide positively between these values. But as Siewert has pointed out probable sources of error in Berlin's work, I am inclined to give preference to the lower value.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 17, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following gentlemen were declared by the Scrutators, Dr. Thorn and Mr. D. A. Louis, duly elected Fellows of the Society:—B. H. Brough, G. Daubeney, C. C. Hutchinson, W. S. Kilpatrick, E. Matthey, H. Peile, J. W. Pallister, R. Romanis, S. G. Rawson, F. M. Rogers, W. Robinson, T Stenhouse, W. O. Senier, J. A. Voelcker.

The following certificates were read for the first time:—L. Archbutt, W. H. Barr, D. Bain, P. S. Chantrell, H. C. Draper, A. F. Damon, V. Edwards, W. T. H. Elsley, T. Hilditch, R. E. Moyle, P. Morton, W. J. Orsman, F. R. Power, H. G. Shaw, E. F. Smith, A. E. Simpson, A. Tarn.

The PRESIDENT then called on Mr. C. T. KINGZETT to read a paper "*On Camphoric Peroxide and Camphorate of Barium.*" Brodie states (*Phil. Trans.*, 1863, 407) that

when anhydrous camphoric acid is triturated with an equivalent quantity of hydrated barium peroxide in the presence of ice-cold water and the mixture filtered, there is obtained a solution which is slightly alkaline, and which, when rendered acid, has the following properties:—It bleaches indigo, oxidises potassium ferrocyanide, decomposes hydriodic acid, and evolves oxygen when heated, but fails to give a blue colouration with chromic acid, and does not discolour potassium permanganate. Brodie concluded from his analyses, &c., that a new substance was formed which was a barium salt of camphoric peroxide, $C_{10}H_{14}BaO_5$, and not a camphorate of barium peroxide. The author believes that Brodie's experiments admit of another explanation, which is probably correct, viz., that when camphoric anhydride is triturated with water and barium peroxide, the anhydride is first resolved by the addition of a molecule of water into camphoric acid, which in its turn decomposes barium peroxide, forming camphorate of barium and peroxide of hydrogen. The author then gives a detailed account of his repetition, with some slight variations, of Brodie's experiments: he concludes that barium peroxide only acts upon camphoric anhydride in the presence of water, and that the action is of a secondary character, the anhydride first becoming camphoric acid, which decomposes the peroxide of barium, and yields camphorate of barium. He also incidentally proves the existence of a crystalline hydrate of camphorate of barium containing one molecule of water.

$$C_{10}H_{14}O_3 + H_2O = C_{10}H_{16}O_4.$$
$$C_{10}H_{16}O_4 + BaO_2 = C_{10}H_{14}BaO_4 + H_2O_2.$$

Dr. Armstrong said that no doubt some organic peroxides, as acetic peroxide, did exist. In Mr. Kingzett's communication he had called attention to the results of one of his previous papers, in which he claimed to have shown that, by the air-oxidation of turpentine, camphoric peroxide was formed, which was the source of the peroxide of hydrogen; no doubt some peroxide was formed, but that this should be camphoric peroxide appeared to him very doubtful, as there seemed to be no relation between the terpenes and camphor.

Mr. Kingzett, in reply, said it was principally from Brodie's experiments that he had concluded that camphoric peroxide was formed in the oxidation of turpentine; although peroxides of monobasic acids were known, if camphoric peroxide did not exist, he did not think any peroxides of bibasic acids had yet been discovered.

The Secretary then read the following communications:—

"*Supplementary Note on Liebig's Production of Fulminating Silver without the use of Nitric Acid*," by E. Divers and Michitada Kawakita. The authors have succeeded in obtaining a very small quantity of fulminate by the action of nitrous acid, but under conditions which deprive its production of all significance. The fulminate was only produced when the temperature rose to about 60°, and the liquid contained nitric acid.

"*On the Decomposition of Silver Fulminate*," by E. Divers and Michitada Kawakita. Silver fulminate when treated with hydrochloric acid yields, as is the case with mercury fulminate, formic acid and hydroxy-ammonium chloride, but the authors have as yet only found two-thirds of the calculated quantity of each of these bodies. Traces of ammonia and hydrocyanic acid are also produced.

"*On Hyponitrites*," by E. Divers and Tamemasa Haga. In this paper the authors resume an investigation commenced by Divers in 1871. They criticise especially the results and conclusions of Berthelot and Ogier, who gave to silver hyponitrite the formula $Ag_4N_4O_5$. These chemists do not seem to have thought that an acid of such a strange constitution as $H_4N_4O_5$ might be a mixture of hyponitrite, having Divers's constitution (HNO), mixed with nitrite and nitrate. The authors of the present paper have made many experiments purifying the hyponitrite in various ways. The final experiment consisted in dissolving the hyponitrite in nitric acid, precipitating with sodium carbonate, washing with water, acetic acid, and again with water; all the operations being performed in an atmosphere of carbonic acid. This resolution and reprecipitation was performed several times. The product was finally dried in an atmosphere of carbonic acid over sulphuric acid. The salt gave 77·69 per cent of silver; AgNO contains 78·3 per cent. The constitution of the salt is therefore AgNO. The authors have hitherto failed to prepare hyponitrites either by Menke's method, heating potassium nitrate with iron filings, or by Zorn's process of using ferrous hydrate as the reducing agent.

Dr. Japp pointed out that Zorn had prepared an acid barium hyponitrite, and had shown that nitrous oxide was evolved when a hyponitrite was heated.

The Society then adjourned to Feb. 7th, when a paper "*On the Influence of the Temperature of Distillation on the Composition of Coal Gas*" will be read by L. T. Wright.

NOTICES OF BOOKS.

Bleaching, Dyeing, and Calico-Printing, with Formulæ. London: J. and A. Churchill.

Whoever first conceived the idea of producing a practical treatise on bleaching, dyeing, and calico-printing within the compass of 200 small pages has certainly given no bad proof of courage, and may be congratulated on the fact that the resulting work is more valuable than might have been reasonably expected. The recipes for producing various colours in dyeing and printing, though few in number, are well-selected, and are for the most part fairly on a level with modern practice.

The weakest part of the work is the section on dye-wares, or, as the author prefers to call them, dye-stuffs. Some of much importance, such as gall-nuts, sumac, myrobalans, calliatura-wood, chestnut-bark, gardeniapods, monarda, sooranjee, tamarac, have been omitted. Among the aniline dyes we find in this section no mention of methyl and malachite green, though they are prescribed in some of the receipts for dyeing. On the other hand, certain colours, both natural and artificial, which figure here might have been omitted without any loss. Such are saffron, rhubarb, kermes, lo-kao, cinchonine, murexide, emeraldine, aldehyd green, &c There can be also little occasion in so small a book, intended for the use, not of the manufacturer of colours, but merely of the dyer, to describe the preparation and purification of aniline and anthracene.

By a curious oversight cam-wood is said to be a synonym for Brazil wood. Considering that the two differ in their origin, in the shades which they produce, in their fastness, and in the solubility of their respective colouring-matters, we are at a loss to account for this statement. Woad in these days is used in the vat for wool-dyeing, not as a dye, but merely as a promoter of fermentation. The notice of sulphate of indigo—the acid or "sour" form only—is mixed with instructions for vat dyeing in a manner which might prove perplexing to a beginner.

Concerning the adulterations of annatto, of which a formidable list is here given, on the authority of Dr. Hassall, we are somewhat sceptical. The alleged sophistications may possibly be found in samples purchased in the retail trade; but as obtained from the drug brokers and large drysalters it is fairly genuine. To incorporate turmeric with annatto, as alleged by Hassall and others, would be a tedious, and therefore unremunerative, operation.

A few typographical errors may be noted, in the probable event of another edition. Thus, for Tessié du Mothay, we find Tessié du Mathey; for ferrocyanide of tin, in the index, ferrocyanide of *tar*; for Hofmann violet, likewise

in the index, Hoffman violet, though the name is given correctly in the body of the work; for erythrosine, erythnosine, &c.

To sum up our opinion of this work we may say that the practical sections—those parts especially which appear to have been furnished by Mr. James Chadwick, of Manchester,—will prove useful, whilst the errors in the fourth chapter will soon be rectified by any person actually engaged in the tinctorial arts.

The Retrospect of Medicine. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxviii., July to December, 1883. London: Simpkin, Marshall, and Co.

Among the memoirs and abstracts here requiring notice is one by Dr. J. Lowe on the "germ-theory" of disease. The writer holds that germs may exist in wounds without producing evil, and that the antiseptic treatment proposed by Mr. Lister may be so modified that it is practically abolished, yet without involving the risk of blood-poisoning.

Dr. J. Milner Fothergill, in an article on "Stewed Fruit for the Gouty and Dyspeptic," proposes to neutralise, or partially neutralise, its acidity by the addition of alkaline carbonates. Concerning the medicinal value of fruit so prepared, we, of course, are not entitled to speak; but some quarter of a century ago it was once our evil lot to dine with a friend whose better half had a fancy for deacidifying fruit pies on this principle. A more disagreeable flavour we rarely encountered.

Dr. C. H. Ralfe recommends caution in the use of picric acid as a test for modified albumen in urine, since it also precipitates mucine.

Dr. Oliver, for the detection of albumen in urine, proposes to add to a little of the suspected sample, potassium mercuric iodide and citric acid solution. If albumen is present a white precipitate almost immediately falls to the bottom of the tube. To adapt this test to medical use he prepares slips of paper, steeped respectively in the potassium mercuric iodide solution and in citric acid. The reaction may be successfully obtained by adding to the sample first a slip of the former paper and then one of the latter kind.

For the detection of sugar in urine he employs also two papers, the one prepared with sodium sulpho-indigotate —extract of indigo—and the other with sodium carbonate. One of each kind of paper is dropped into a test-tube, covered with water, and a drop or two of the urine in question is added. The whole is then boiled over a candle or gas flame. The colour of the extract of indigo dissolves out into the water, and if sugar is present the blue colour changes first to a green, then to a red, finally becoming yellow or colourless. On cooling and exposure to air the blue colour is gradually restored.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 26, December 24, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Verification of Galvanometers. — E. Ducretet.—Galvanometers ought to be frequently verified in consequence of the variations of the magnetic field, due especially to the variations of the directing magnet of the galvanometer. For this purpose the author transforms the directing magnet into a kind of electro-magnet, by fitting it with coils of wire of a certain resistance. In order to magnetise this bar of steel, he passes into the coils, for a given time, the current of several Daniells with large surfaces. The circuit of these coils being very resisting, the battery does not become polarised.

Researches on the Duration of the Solidification of Superfused Sulphur.—D. Gernez.—The duration of the solidification of the octahedral crystals is much longer than that of the prisms; being often 100 times greater, and rarely descending as low as 25 times.

The Decomposition which the Phosphates of the Earthy Alkaline Bases undergo in Presence of Water. —A. Joly.—The decomposition of these salts by water is of quite a different nature from that of bismuth nitrate, antimony chloride, &c. Not only the weight of free phosphoric acid increases constantly in the solution simultaneously with the weight of the mono-basic phosphate decomposed, but the relation between the total phosphoric acid and the combined phosphoric acid increases in the same manner. If further quantities of the salt are added it dissolves in the acid liquid without decomposition.

Heat developed on the Neutralisation of the Alkaline and Earthy-alkaline Bases by Hydrofluoric Acid. —M. Guntz.—A thermo-chemical paper, which does not admit of useful abstraction.

Creatines and Creatinines. — E. Duvillier. — The author gives an account of ethyl-amido-α-butyro-cyamidine. This compound, $C_7H_{13}N_3O$, forms fine, limpid, tabular, anhydrous crystals, which generally arrange themselves like the leaves of a half-open book. They are very soluble in water and alcohol.

Action of Ammoniacal Gas upon Methyl Nitrate. —E. Duvillier and H. Malbot.—The authors pass a current of ammoniacal gas into methyl nitrate mixed with about one-tenth of its volume of methylic alcohol, and contained in a flask fitted with a cohobator. The principal product of the reaction is tetra-methyl-ammonium nitrate, a salt very convenient for the preparation of pure tri-methylamine. Mono-methylamine is produced in smaller proportion, besides traces of di- and tri-methylamine.

Compound Oxygenated Ammonias.—M. Reboul.—By the action of epichlorhydrine upon diethylamine the author obtains hydroxallyl-tetrethyl-diamine, a very stable base which boils without decomposition, at the ordinary atmospheric pressure, at 236° to 238°. A homologue of this base, hydroxallyl-diethyl-diamine, is obtained by the action of epichlorhydrine upon ethylamine.

Certain Haloid Derivatives of Ethane.—L. Henry. The author describes mono-chlorinised ethylene bibromide ethylidene bibromide, and monobromised ethylene bibromide.

Calcium Chloro-silicate.— M. Le Chatelier.—The author has succeeded in obtaining this compound in distinct crystals.

No. 27, December 31, 1883.

The Action of Heat upon Aldol and Paraldol.— Ad. Wurtz.—The author has studied this action at 100°, 125°, and 170°. In the first place he describes the results obtained at the highest temperature. The principal product is crotonic aldehyd, which is formed along with water. But along with traces of regenerated aldehyd there are formed other products according to the nature of the aldol employed. If the latter is impure, giving off a strong odour of crotonic aldehyd, the product of the reaction is formed of two strata; the lower aqueous layer is colourless, whilst the higher stratum is deep brown or black, consisting principally of crotonic aldehyd, along with other products insoluble in water and of high boiling-points, to which the author will return in a future communication. With a purer aldol the product of reaction is colourless and homogeneous, containing a smaller quantity of crotonic aldehyd, and a compound soluble in water, which the author has particularly studied. It is a thick colourless

liquid, of the density 1·0941 at 0°. At the ordinary pressure it boils at 280°. Its formula is probably, $C_4H_8O_2$.

Reply to the Observations of M. Larroque on Experiments concerning the Study of Telluric Currents.—E. E. Blavier.—The author traverses a number of assertions made by M. Larroque in his recent communication to the Academy.

Temperature obtained by Means of Boiling Oxygen and the Solidification of Nitrogen.—S. Wroblewski.—Inserted in full.

Maximum Solubility of Sodium Sulphate.—E. Pauchon.—Kirchhoff's formula renders it possible to foresee and to determine the position of the maximum solubility of sodium sulphate.

An Incomplete Oxygenated Monamine, Oxallyldiethylamine.—E. Reboul.—This compound, which contains 65·1 per cent of carbon, 11·7 of hydrogen, and 10·8 of nitrogen, is a thick colourless liquid, extremely soluble in water, and of a strong odour, like that of diethylamine. It turns gradually yellow on exposure to light. Its boiling-point is 160°.

Sodium Fluorides.—M. Guntz.—A thermo-chemical paper, which does not admit of useful abridgment.

Researches on the Ptomaines and on Analogous Compounds.—A. Gabrial Pouchet.—The author's experiments have already led him to regard the alkaloidal compounds existing in the excretions as identical with, or at least closely similar to, those which take their rise during the putrefaction, in the absence of air, of proteic matters, and of various organs of the animal system. The basic bodies extracted from both these classes of matter are probably mixtures of homologous bodies. By a tedious process he obtains two distinct classes of compounds, a liquid portion, dialysable only with difficulty, and a portion containing crystallisable substances and readily capable of dialysis. For the former the author reserves for the present the name "extractive" matter of urine. Among the products of putrefaction the same two classes of compounds are recognised. The volatile bases found in the crystallisable portion resemble the hydropyridic bases detected by MM. Gautier and Etard. All the compounds isolated are violent poisons for frogs which they kill rapidly, occasioning torpor and paralysis, with abolition of the reflex movements.

Action of Copper upon the Human Economy: History of a Workshop and of a Village.—MM. A. Hulés and De Pietra-Santa.—The authors give an account of Durfort, a village of Tarn, where the workmen pass twelve hours daily in the midst of an atmosphere of copper oxide. Their skins, hair, and beards are coloured with copper. The same metal can be detected in their secretions and excretions, and after death in their bones. These people suffer from no special trade disease, and on the other hand they enjoy no special immunity from infectious diseases, and in particular from cholera or typhoid fever.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 11.

The Water of the Danube, and the Projected Irrigation of the Marchfeld.—J. F. Wolfbauer.—In 10,000 parts of Danube water the author found potassium sulphate 0·034, sodium nitrate 0·028, and organic matter 0·056. There is here no mention of phosphates, though it is afterwards stated that if the Marchfeld receives during the season of 180 days 18,000 cubic metres of water per hectare, the soil would be enriched with 4·1 kilos. phosphoric acid.

Chemical Procedures in the Soil and in Subsoil Waters, and their Sanitary Importance.—F. Hoppe-Seyler.—The author argues that a soil can be judged from a sanitary point of view neither from the carbonic acid found in the ground-air, nor from the nitrous and nitric acid in the subsoil waters. He contests the notion recently promulgated that the bodies putrefying in churchyards, &c., are harmless.

Forest as a Protection against Hail.—Prof. L. Glaser.—A number of observations made in Switzerland, Italy, &c., showing that the clearing of mountain ridges has been followed by an increase of hail-storms.

Hygroscopic Power of Soils as regards the Submersion of Vineyards.—P. Pichard.—From the *Comptes Rendus*.

Contributions to the Development of the Theory of Manures.—Prof. Paul Wagner.—In this extensive memoir the author points out as essential in all manurial experiments:—(1) Equalisation of all the factors of fertility (especially of the moisture of the soil), with the single exception of the agent to be tested. (2) Diminution of experimental errors by adding together the results of a sufficient number of parallel experiments, and by bringing to bear as far as possible the relative maximum or optimum of all the factors of fertility, with the exception of that (or those) in question. (3) Determination of the limits of error.

MISCELLANEOUS.

Society of Arts.—On Monday, the 28th inst., Mr. Thomas Bolas will deliver, at the Society of Arts, the first of a Course of Cantor Lectures on "Recent Improvements in Photo-Mechanical Printing Processes," in which he will deal with new developments of the Woodbury type process. The second lecture, on February 4th, will be on type blocks from line drawings and half tone subjects; and the third and concluding one on February 11th, will be devoted to the consideration of intaglio plates, collotypes, photo-mechanical methods as applied in the decoration of pottery and miscellaneous processes.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soapstone.—In your issue of November 23rd a correspondent (J. H. T.) asks for uses of soapstone. Allow me to mention a few I know of. Soapstone in lumps is cut into gas-burners, electric insulators, griddles, slate pencils, hair curlers or crimpers, linings for stoves, &c. In making gas-burners and insulators, it is turned to the proper form in a lathe, the stone being quite soft in its natural condition. When finished, the result is heated to a red heat in a suitable furnace, then cooled slowly, when we get a very hard and yellowish coloured article, unacted on by moisture and acids. The turnings and dust are largely used for mixing with lubricating compounds, also for making cements, using silicate of soda as an agent.—X. Y. Z.

MEETINGS FOR THE WEEK

MONDAY, Jan. 28th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.
TUESDAY, 29th.—Institute of Civil Engineers, 8.
—— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
—— Society of Arts, 8. "Canada as it will appear to the British Association in 1884," by Joseph G. Colmer.
WEDNESDAY, 30th.—Society of Arts, 8. "Coal-gas as a Labour-saving Agent in Mechanical Trades," by T. Fletcher, F.C.S.
THURSDAY, 31st.—Royal, 4.30.
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
—— London Institution, 7.
FRIDAY, Feb. 1.—Royal Institution, 8. "Rajah Rammohun Roy," by Prof. Max Müller, at 9.
SATURDAY, 2nd.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.

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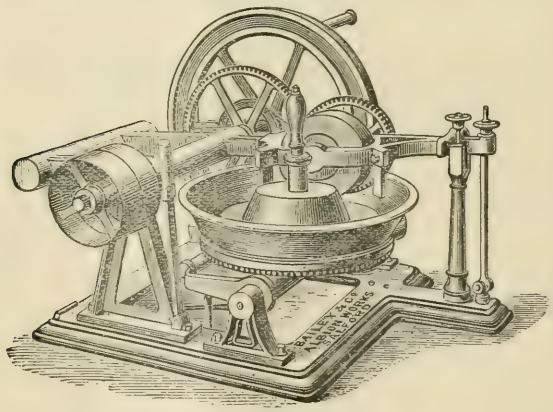

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THE CHEMICAL NEWS.

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ON A NEW METHOD OF GENERATING ELECTRICITY.*

By J. A KENDALL, F.I.C., F.C.S.

In 1863 Deville and Troost announced their discovery that certain metals were permeable by hydrogen at a red heat. This discovery, as is well known, was verified by Graham, who made extended researches on the subject.

About three years ago it occurred to the author that a red-hot platinum plate, through which hydrogen was passing, might be made to serve as an element of a galvanic combination, and early in 1881 some experiments were tried with this object.

These were continued from time to time up to the present, and in this paper it is proposed to give some account of the experiments and their results. The subject appears to the author to require much more extended researches in several directions than he has been able to make, but it is hoped that by giving an account of the researches hitherto made, the points which require further investigation will suggest themselves to physicists and chemists.

In the earlier experiments the author constructed small tubes of platinum foil. These were sealed up at one end by the oxy-hydrogen blowpipe, and to the open ends glass tubes were fused. Platinum conducting wires were fastened to the tubes. By means of the glass tubes gases could be conveyed to the interior of the platinum tubes.

A platinum crucible was used at the other element of the cell, it had a platinum conducting wire attached, and was supported over a Bunsen burner. A small platinum foil tube was then held in the centre of the crucible, and the cell was completed by putting the transmitting medium into the crucible. After unsuccessful trials with alkaline nitrates, &c., glacial phosphoric acid was selected. Some of this substance was put into the crucible and fused so as to nearly immerse the platinum foil tube.

On connecting the two wires with a galvanometer no deflection was observed when the crucible and contents were heated to redness in the oxidising flame of the Bunsen burner. When, however, hydrogen gas was supplied to the inner platinum tube, an immediate production of electricity was perceived. The tube of platinum foil containing hydrogen was seen to correspond to the zinc element in an ordinary galvanic cell.

This experiment being verified other substances were tried instead of phosphoric acid.

Sulphuric acid nearly at its boiling-point gave a slight current.

Chloride of sodium in the fused state gave a very good result. Then the chlorides of potassium, calcium, and the alkaline earth metals were tried with similar results.

As might be expected the production of electricity increased with the temperature.

It was, however, soon found that the production of the current was stopped if the flame of the Bunsen burner did not ensure perfect combustion on the exterior of the platinum crucible.

Experiments showed that if a reducing flame was applied to the crucible while the small tube contained air, then a current of electricity in the reverse direction was obtained.

Tubes of palladium foil substituted for the platinum tubes gave similar results.

After a number of trials with tubes of platinum foil, an apparatus was constructed of two platinum tubes closed at one end.

The inner tube was 4 inches long and $\frac{3}{8}$ inch internal diameter, while the outer tube was $3\frac{3}{4}$ inches long, and $\frac{5}{8}$ inside diameter. The thickness of metal was $\frac{1}{100}$ inch in both tubes.

The two tubes when used for these experiments were arranged upright in a small Fletcher's gas furnace, the inner tube being supported at any desired height in the centre of the larger tube and connected with a supply of hydrogen.

Numerous experiments were made with this apparatus. The temperature could be easily regulated from a dull red heat to a white heat, and various saline substances could be tried as media.

The fused sulphates, carbonates, and nitrates were found to be unsuitable for the production of the current. The results obtained with fused chlorides, &c., showed that the hydrogen not only passed through the metal of the inner tube, but also through the fused saline medium and then through the outer platinum tube.

In recent experiments with this apparatus it appears that when a good transmitting substance is used between the tubes, and when about 3·3 square inches of the inner tube are in contact with the medium, the amount of hydrogen gas which passes through the metal at a nearly white heat is about 0·7 cub. centim. per minute. This volume of course refers to hydrogen at ordinary temperatures.

The use of this apparatus led to the discovery of a large number of substances which would serve as media by allowing the transmission of hydrogen.

The list of saline bodies was extended to the bromides, iodides, and fluorides of the alkaline and earth metals, but the most important discovery in this direction was that vitreous bodies such as glass, and even vitrified bodies as porcelain and earthenware, acted as media when at a red heat. Attention was then directed to the use of vitreous media for several reasons.

In experiments with fused saline bodies the use of common metals was precluded owing to their being corroded by fused salts, and although iron is known to be permeable to hydrogen at a red heat, yet its oxidisable qualities prevented any satisfactory results being obtained when it was substituted for platinum.

However, when vitreous matters were used instead of fused salts, it became possible to use other metals for these experiments.

A number of trials were made by taking tubes of fusible soda-glass. A small tube of the metal to be tested was then placed inside the glass, and while passing a slight current of coal-gas to prevent oxidation of the metal, the glass was carefully fused on to the metal. The external surface of the glass while soft was then coated with thin platinum foil or with other metals.

On connecting the inner and outer coatings with a galvanometer, passing hydrogen through the tube, and then heating it to redness, the usual current of electricity was produced.

The quantity of electricity generated both with these cells and with the platinum tubes was in proportion to the surface heated.

The most powerful effects were obtained when the metallic coating was in the pulverulent form. Spongy platinum, for example, when made to adhere closely to the glass gave a strong current with hydrogen.

When using thin metallic plates in the interior of the tubes it was found necessary to employ very thin platinum foil on the exterior, as the hydrogen otherwise accumulated to some extent on the inner plate, thus spoiling the cell.

A good result might often be got by painting the external surface of the glass with an alcoholic solution of platinic chloride, and then igniting. By this means a very thin film of metallic platinum was left on the glass, and by means of a spiral of platinum wire also put round the glass, sufficient conduction was obtained.

* A Paper read before the Royal Society, Jan. 17th, 1884.

As glass exerts only a slight action on metallic iron at a red heat, thin sheet iron ($\frac{1}{100}$ inch) was used in numerous experiments, but this does not make a perfect arrangement when glass containing alkali is used, as the alkali metal is liberated by the iron at a very strong heat.

A number of metals were tried either in the form of sheet or as a powdery deposit.

This latter form might frequently be obtained by coating the interior of the glass tube with the oxide of the metal to be tried, and then reducing the metal by hydrogen or coal-gas upon the surface of the glass.

The following metals were tried and found to transmit hydrogen and cause the production of electricity :—

Platinum.	Molybdenum.
Palladium.	Copper.
Gold.	Silver.
Iron.	
Nickel.	

The relative transmitting powers were not, however, ascertained. There can be little doubt that the property of transmitting hydrogen at a red heat belongs to most, if not all, metallic bodies.

In the course of the experiments it was observed that the glass used was practically a non-conductor of electricity from one or two galvanic cells when it was heated to redness in an oxidising flame.

When, however, hydrogen was supplied to the glass either inside or outside of the tube it at once became a good conductor of the current.

It was found necessary to avoid using glass containing metallic oxides reducible by hydrogen, as these oxides by reacting upon the hydrogen on the surface of the transmitting plate cause frothing of the glass, thus destroying that absolute contact between the metal and the glass which is required for the production of the electric current.

Experiments were made with tubes of Berlin porcelain, and satisfactory results were obtained. It was found convenient to cover the surface of the tube both inside and out with melted glass and then to carefully lay platinum foil upon the glass, so as to get as perfect an adherence as possible. It appears to be best to have a much thicker metallic plate on the inner side of the cell than on the outside. The author has not determined the most advantageous conditions precisely as yet. Cells were also constructed of clay, containing a percentage of glass, porcelain of various kinds, &c.

The amount of hydrogen transmitted in a given time through the arrangement described varies greatly according to the nature of the medium and the nature of the metallic layer.

With pulverulent metals and a medium of soft glass the rate of transmission of hydrogen may be as high as 0·6 cub. centim. per square inch per minute at a full red heat. With Berlin porcelain tubes, however, the transmission does not usually exceed 0·2 cub. centim. per square inch per minute, even at a white heat, while at a red heat the rate is much lower. With platinum tubes of $\frac{1}{100}$ inch thick the transmission may be from 0·1 cub. centim. to 0·2 cub. centim. per square inch according to the temperature.

The electromotive force of the new cells varies according to the media used, and this subject will of course require further investigation. It was found, however, that the platinum tube cell gave, with borate of lime at a nearly white heat, an electromotive force = 0·36 of a Daniell, whilst a cell constructed of Berlin porcelain tube $\frac{1}{32}$ inch thick gave an electromotive force = 0·7 of a Daniell when worked at a nearly white heat.

Although many gaseous mixtures containing free hydrogen will serve to produce the electrical reactions, yet experiments with carbon monoxide have given no similar result in conjunction either with iron or platinum plates.

Before describing further researches which the author has made on the subject of electrical currents produced by hydrogen, it may be well to mention that the galvanometer generally used in the experiments yet to be described, as well as in the former experiments with metal tubes, &c., is one adapted for rather strong currents and it has very slight resistance. It has been graduated by means of a voltameter.

As these experiments must be regarded more as qualitative than quantitative, it will perhaps be sufficient to give four points of deflection with the corresponding liberation of hydrogen in a voltameter.

Deflection of galvanometer.	Liberation of hydrogen per minute.
10°	0·07 c.c.
20	0·21 ,,
30	0·60 ,,
40	1·35 ,,

The above figures also show, in a roughly approximate way, the amount of hydrogen which must be supplied to a cell of the new construction in order to give the deflection indicated.

In continuing his researches the author has found that strongly heated hydrogen may give rise to electrical currents under a variety of circumstances.

Small cells were made by nearly covering short wires or rods of metal with melted glass. The glass was then covered with platinum foil and the two metals were connected by wires with the galvanometer. On heating a cell of this construction in an oxidising flame an electrical current was almost invariably produced, due to the withdrawal of hydrogen from the inner wire or rod. When the current diminished in force a reducing flame containing free hydrogen was applied to the cell. This immediately caused an energetic reverse current, accompanied by the re-absorption of hydrogen by the inner metal. Then with an oxidising flame the original effect could be produced. These results were obtained with wires of platinum, nickel, iron, and copper. In working with cells of this description made with iron rod, it was found that a current of electricity of long duration could be produced by the oxidising flame. This result appears to be due to the continuous absorption of hydrogen liberated from aqueous vapour by that portion of the iron which was not covered by glass.

When the entire surface of the iron was covered by glass (with the exception of the conducting wire, which was away from the heat) then the deflection of the galvanometer gradually came to zero when the cell was heated in an oxidising flame.

Recently experiments have been made with a differently arranged apparatus, as follows :—

A platinum tube, 5¼ inches long and 1 inch diameter, was set upright in a Fletcher's gas furnace and nearly filled with a fusible glass composed of the diborates of lime and magnesia. This apparatus being heated to bright redness, a plate of platinum, 2 inches long and 0·6 inch wide, suspended by a platinum wire, was immersed in the fluid glass. The platinum tube and the plate being connected with the galvanometer, the phenomena of alternate electric currents could be produced with great facility by altering the nature of the flame in the furnace. When the platinum tube was surrounded with a visible pale flame there was an electrical current from the tube to the plate until the plate was apparently saturated with hydrogen. When more air was supplied to the furnace, so as to cause more perfect combustion, the needle of the galvanometer was violently reversed. The deflection produced on the galvanometer by either the "normal" or "reverse" current was at first 18° or 20°, and it fell to nearly zero within ten or fifteen minutes.

These effects could of course be repeated as often as required.

It appears quite plain that the hydrogen in flames has a powerful molecular or atomic action.

If glass be fused in a large platinum crucible heated by flame as in a Fletcher's furnace, bubbles of hydrogen may

be observed forming and rising from the sides of the crucible, especially at the hottest parts.

If a platinum tube like that used for the experiments with the suspended plate be somewhat cooled while nearly full of melted glass, so that the glass becomes very viscous, then by applying a flame containing free hydrogen to any spot on the lower part of the tube the latter may easily be burst by the bubble of hydrogen which is formed on the inside of the tube.

Experiments have also been tried in which the hydrogen coming through a cell was removed by means of a Sprengel pump. One experiment may be described:—A platinum tube 2¾ inches long and ⅜ inch diameter, closed at one end, was soldered to a strong iron tube and fixed vertically. The platinum tube was immersed for 2¼ inches in fused glass contained in a platinum cell. This latter was 2¾ inches deep and 1 inch diameter.

The two platinum tubes were connected by platinum wires with the galvanometer, and the iron tube was connected with a Sprengel pump.

The cell being heated to bright redness in an oxidising flame, a good vacuum was produced by the Sprengel pump. Then, while no bubbles of gas came down the fall tube of the pump, the galvanometer showed no deflection.

The cell was then heated by a reducing flame. The galvanometer soon gave a steady deflection of 15°, and bubbles of hydrogen came down the fall tube of the pump. The experiment was continued for half an hour, and during fifteen minutes the hydrogen coming down the fall tube was collected. It measured 1·33 cub. centims.

From occasional experiments with several vitreous mixtures the conclusion formerly arrived at by the author regarding their electric conductivity is confirmed, viz., that these fused vitreous matters do not conduct electricity of low tension unless hydrogen be present. When working with large cells it is, of course, difficult to avoid the presence of hydrogen if the cell be heated by flame.

It appeared desirable to try whether any hydrogen could be made to pass through the walls of a porcelain tube either under the influence of oxygen or by means of a vacuum.

A glazed Berlin porcelain tube 20 inches long and ½ inch diameter was sealed up at one end and connected with a Sprengel pump. The closed end of the tube exposing a surface of 4 square inches was heated to whiteness in the gas furnace, but no hydrogen could be drawn by the Sprengel pump when the porcelain tube was heated in a reducing flame.

After this the porcelain tube was filled with hydrogen, and the same part as before was heated in an oxidising flame, but no loss of hydrogen from the tube could be perceived during half an hour.

Somewhat similar experiments have also been made with glass tubes with negative results.

The author has also made a few experiments to ascertain the influence of a voltaic current in increasing or diminishing the flow of hydrogen through the medium, but so much depends upon the structure of the metallic surfaces in contact with the medium and their relative sizes, as well as upon the electromotive force, &c., of the battery used, that this subject would probably require somewhat elaborate researches.

The author, however, hopes to make further investigations into the nature of the movements of hydrogen produced in vitreous matters and in metals.

Manufacture of Porous Earthenware by means of Naphthaline.—M. Stein works up the naphthaline into an emulsion with water, or comminutes it in any other convenient manner, and mixes it with the slip. The articles moulded are dried, and then heated sufficiently to expel the naphthaline by exudation or distillation. It is collected for re-using, and the earthenware is then burnt in the ordinary manner.—*Cosmos les Mondes.*

SEPARATION OF GALLIUM FROM TERBIUM, YTTERBIUM, AND THE EARTH PROVISIONALLY NAMED Y_a.

By M. LECOQ DE BOISBAUDRAN.

THE terbia actually used in these experiments has been extracted from gadolinite and still contains much yttria, holmia, erbia, and Y_a. The author has examined the three following procedures:—

1. The hydrochloric solution is treated with an excess of boiling potassa, which dissolves gallium oxide; the last traces are removed by re-dissolving the earths in hydrochloric acid and repeating the treatment with potassa.

2. In the solution containing quarter to one-third of its volume of concentrated hydrochloric acid the gallium is precipitated by means of potassium ferrocyanide. The earths are found in the filtrate.

3. A solution of arsenious acid and an excess of acid ammonium acetate are added to the liquid, which is then treated with a current of sulphuretted hydrogen. The gallium is kept back by the arsenic sulphide from which it is separated in the manner already described.

This process is best adapted for the elimination of small quantities of gallium mixed with much earthy oxide.

Separation from Scandium.

This separation is effected by means of the two following methods, but it does not succeed with potassium ferrocyanide.

1. Scandium oxide is thrown down by boiling potassa, which readily dissolves gallium oxide. If accuracy is desired the scandia is re-dissolved in hydrochloric acid and again treated with potassa.

2. The gallium is thrown down by sulphuretted hydrogen in a liquid containing arsenious acid and an excess of acid ammonium acetate. This method is advantageous when there is but little gallium in the substance under examination.

Separation from Fluorine.

1. Gallium chloride is not precipitated by ammonium fluoride in a liquid acidified with hydrochloric acid. This property may be utilised for separating the gallium in the state of ferrocyanide, operating either in the cold or at a gentle heat upon a solution containing from quarter to one-third of its volume of concentrated hydrochloric acid. The fluorine is sought for and determined in the filtrate by known methods. In this manner there may be found either little gallium mixed with much alkaline fluoride, or very little fluoride mixed with much of a salt of gallium.

2. If the fluorine is not to be determined directly, it is merely needful to heat the substance with an excess of sulphuric acid until abundant white fumes are given off. The gallium is then extracted from the residue by means of one of the processes already described.

The fluorine may also be expelled by fusion with ammonium bisulphate.—*Comptes Rendus.*

ACTION OF DAYLIGHT AND OF THE ELECTRIC ARC-LIGHT UPON COLOURS USED IN DYEING AND IN PAINTING WITH WATER- AND OIL-COLOURS.

By M. DECAUX.

THE author refers first to the researches of Dufay and Hellot undertaken in order to classify the colours into fixed and fugitive, and expresses regret that the rules based upon this regulation have been permitted to fall into abeyance.

As regards the action of sunlight or diffused daylight upon colours fixed in dyeing, M. Decaux proves by a long series of comparative experiments that the shades dyed

upon wool in the vat, with Prussian blue, cochineal, madder, weld, and even fustic, are much more permanent than those obtained with Nicholson blue, magenta, jaune d'or, and picric acid. Four of the coal-tar colours differ from the rest of their class as regards stability, *i.e.*, the ponceau called naphthol carmine, orange No. 2, chrysoine, and artificial alizarin.

Colours for painting in water and in oils are divided into the absolutely permanent, the moderately permanent, and the fugitive. If used with water all the most beautiful reds, carmine, carmine-lake, most madder lakes, and vermilion, fall under the fugitive class. If mixed with oil the madder lakes rank as moderately permanent.

The action of the arc light is similar to that of the sun, but has only one-fourth of the power.—*Bulletin de la Société d' Encouragement.*

DETERMINATION OF THE TANNIN IN VEGETABLE PRODUCTS, AND ESPECIALLY IN THE BARKS OF THE OAK, BIRCH, FIR, QUEBRACHO, CINCHONA, IN DIVIDIVI, GALLS, &c.

By M. PERRET.

I. For barks of certain kinds 20 grms. are sufficient for the determination. In other cases it is necessary to operate upon 100 grms. freed from moisture, the loss being taken into account in calculating the results.

II. The substance taken, of whatever kind, is submitted to two successive boilings of 15 minutes each with distilled water. The two liquids are poured together into a porcelain capsule and evaporated down to 100 c.c. The liquid must be boiling and clear, having been filtered. It is then let cool down to 70° and there is added by degrees, but within the time of two miuutes and with constant stirring, a solution of dried egg-albumen, standardised to one-fifth, as long as a precipitate is formed. The heat is kept up without regarding any excess of albumen which may have been employed, and is raised to 100°; the liquid thus freed from tannin passes in bubbles through the mass, which is almost colourless.

III. At this moment there is added from a Mohr's burette, a decinormal solution of dry aluminium sulphate until the deposit, which was previously of a spongy texture, becomes compact and granular and separates from the mother-liquor. It is let cool, and brought upon a tared filter. The precipitate is washed with hot water and dried in the stove upon a cake of plaster.

IV. When the weight has become constant there are deducted from it the weights of the filter, of the albumen, and of the sulphate of alumina corresponding to the number of c.c. of these solutions actually employed. The difference then gives the weight of the active tannin contained in the substance under examination.

V. The standard decinormal solution of aluminium sulphate is made by dissolving 10 grms. of the dry sulphate so as to make up 100 c.c. of a solution, unfiltered.

VI. The solution of egg-albumen is obtained by dissolving 20 grms. of the dry egg-albumen of commerce in distilled water sufficient to make up 100 c.c. of an unfiltered solution.

The author asks what becomes of the sulphuric acid in the aluminium sulphate, but he adds that it disappears absolutely before the fact. The solution at the strength chosen is said to have been found by experience to saturate the tannate of albumen perfectly and convert it into a lake, and "the sulphuric acid, whilst decomposing the calcium, magnesium, &c., tannates, increases exactly by its own weight the quantity of tannin deposited."—*Bulletin de la Soc. Chimique de Paris.*

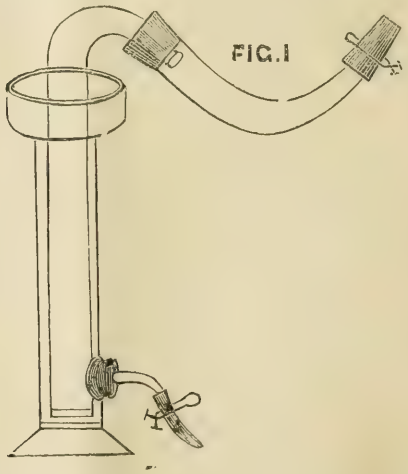
[There are other elements of doubt attached to this process.—*Ed.* C. N.].

SOME CONVENIENT QUANTITATIVE LECTURE APPARATUS.

By ARTHUR MICHAEL.

The need felt by teachers of chemistry not only to present to their hearers the principal facts of their science qualitatively, but also quantitatively, has been the cause of what may be called an evolution in lecture apparatus. This has culminated in instruments, notably by Bunsen and A. W. Hofmann, which are hardly open to improvement as far as simplicity combined with accuracy are concerned. Their deficiency is more in expensiveness, and, especially in regard to Hofmann's apparatus, fragility. In this note some quantitative lecture apparatus will be described, which were devised with the special view of combining sufficient accuracy with stability and cheapness. It is becoming more and more desirable that all students of chemistry should convince themselves of the truth of the most important reactions, and the composition of some of the principal inorganic compounds, from personal observation, and apparatus has become imperative which can be made by anyone having a slight experience in glass-blowing. The aid that a knowledge of glass-blowing affords to a scientific chemist cannot be over estimated. The writer is convinced that a training in it should never be omitted from the course required of students making chemistry their profession.

The trough used is Liebig's well-known instrument slightly modified. Liebig's trough has notably two defects. The eudiometer after the explosion is apt to bump, which often causes an overflow of mercury, and even at times breaking the apparatus. This is remedied by placing a rubber plug on the bottom of the trough, and



holding the eudiometer firmly down on it by means of a retort-clamp. A second defect is in the difficulty of emptying, or adjusting the height of the mercury, even when it does not contain a eudiometer. To obviate this inconvenience a tubulus is brought on the narrow part of the trough, an inch or two above the foot, and fitting into it a cork with a tube bent at right angles and ending in a piece of rubber tubing and spring-clamp* (Fig. 1). The cup of the trough should be three or four inches in diameter, while the narrow part need not be much wider than the largest eudiometer in use. These additions, as slight as they may seem, quite change the apparatus in respect to convenience and handiness.

The eudiometers should be several inches higher than the trough, and may be conveniently divided by calibra-

* A hole drilled by means of a diamond and fitted with a cork and tube will answer the purpose.

tion into twelve equal divisions. In order to render the readings noticeable from a distance, rings of dark rubber are placed over each division. A rubber band, about one-half inch in width, brought over the open end of the eudiometer, will be found to render it less liable to breakage, and is also of use in indicating the proximity of the open end to the surface of the mercury. To obviate the necessity of lowering the eudiometer a number of times while introducing a given volume of gas, it has been found desirable that each instrument should have a second calibration, which is made by introducing successively a unit volume of air, when the eudiometer is held upright, with the upper end of the broad rubber band level with the mercury in the trough. The results are marked in half lines across the instrument, with the number of unit volumes.

In the analysis of gases requiring an absorption of part of the products formed by the explosion a modified eudiometer is used, which obviates the introduction of liquid reagents. The instrument ends in a tube bent in the form of a half-circle, and connected by a rubber tube with a small bulb (Fig. 2). After the explosion, the communication between the eudiometer and the bulb containing the absorption-liquid is opened, and the eudiometer sunk to the bottom of the trough. Owing to the gases being under pressure, the absorption takes place quite rapidly, and is generally finished in one-half to three-quarters of an hour, when the spring-clamp is closed and a second reading taken. The instrument has the further advantage of permitting the examination of the absorption-liquid.

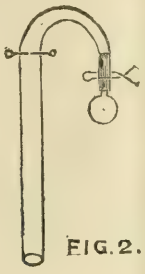


FIG. 2.

Bunsen* has devised a very ingenious apparatus for the purpose of ascertaining the composition of certain oxides by measuring the volume of oxygen used in oxidising a known weight of the element. The following apparatus involves the principle of Bunsen's, but is much more compendious and needs less mercury, without a very great loss in the accuracy of the results. A tube about an inch longer than the trough is graduated, beginning an inch and a half from the upper end, into about 160 to 180 parts of 1 c.c. each. The upper end of the measuring-tube is joined to a tube about three-fourths of its diameter, and bent to form an angle of 45°. This tube is connected by a rubber cork with a curved tube of difficultly fusible combustion tubing, which is drawn out at the other end to a small tube, and closed by a piece of tubing and spring-clamp (Fig. 1).

In the analysis of sulphur and carbon dioxides, when the volmme of the gas after the combustion remains unchanged, the apparatus is about half filled with oxygen. This is done by connecting the open end of the heating-tube with an oxygen generator, displacing the air, then the measuring-tube brought under mercury to 100 c.c., the generator disconnected, and the heating-tube closed. By heating the carbon or sulphur, which is previously placed in the heating-tube—the first, to prevent the tube from cracking on a piece of platinum foil, the latter on a chip of glass—a vivid combustion takes place, which can be seen from a distance. In the analyses of oxides, when the volume after combustion is less then the volume of oxygen taken, the measuring-tube is filled with oxygen to about 20 c.c. from the open end, and a quantity of the element used which requires from 100 to 120 c.c. of oxygen for its combustion. Before heating the substance, the measuring-tube is firmly placed on the rubber plug of the trough, which is then filled with mercury. The results obtained in the analyses of phosphorus pentoxide,* arsenic trioxide, magnesium oxide, &c., are sufficiently accurate to prove the constitution of these compounds beyond a doubt.

Bunsen's apparatus has hitherto only been used in ascertaining the volume of oxygen required for the combustion of certain elements. The above-described apparatus, or a slight modification of it, can be used for ascertaining the composition of a large number of important inorganic compounds, by measuring the volume of gas evolved in the decomposition of a known weight.

In studying quantitatively the decomposition of a substance, potassium chlorate for instance, by heat, a weight, of it which will give off about 120 c.c. of gas is placed on a small platinum boat and brought into the heating-tube. After the mercury is adjusted opposite the zero mark, the substance is heated by a Bunsen burner until the volume of gas in the measuring-tube remains constant, when, after cooling, a second reading will give the volume of gas evolved in the reaction.†

For the purpose of estimating the volume of a gas given off in a wet reaction, the heating-tube is replaced by a small flask of a capacity of 20 to 30 c.c., and connected by a tube, attached to the neck and bent at right angles, to a

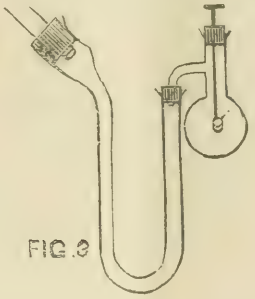


FIG. 3

drying tube. Through a rubber cork in the flask, a glass rod bearing a small perforated platinum basket and marked when the basket is in the upper part of the flask, is brought, and the rod greased that it may be freely moved in the cork. The drying tube is filled with calcium chloride, and connected by a rubber cork with the measuring-tube (Fig. 3). If the gas is soluble in the liquid used for decomposition, the flask is replaced by a small test-tube, on which a mark is brought showing that two or three c.c. of the liquid are used, and a correction made for solubility. For analysis the flask is half filled with the liquid, the glass rod pressed down until the mark is in contact with the upper end of the cork; and after the volume of air in the measuring-tube is read, the basket, containing a weighed quantity of the substance, is brought under the liquid. After the reaction is over the rod is brought back to the original position, and from a second reading the volume of gas evolved is ascertained.

I have not entered into the details of handling the apparatus, because they do not essentially differ from those

* See Heumann, "Anleitung zum Experimentiren bei Vorlesungen uber anorganische Chemie," 52.

* Amorphous phosphorus must, of course, be used in this experiment. The commercial product leaves an ash, which is insoluble in water. It is therefore necessary to purify it, or determine the ash and make the required correction.

† It is well to add a trace of platinum black in the analysis of $KClO_3$. A much smaller heating-tube closed at one end, and the bent open and fitted into the measuring-tube, is advantageously used in such pyro-analyses. That the measuring-tube and trough can be replaced by an apparatus constructed on the U tube principle is evident.

necessary in using an ordinary eudiometer. Before each reading, the mercury in and outside the measuring-tube is brought to a level, and barometric and thermal observations are, of course, necessary. It is evident that three classes of reactions may be quantitatively examined by means of the apparatus. Firstly, those depending on a volume of oxygen absorbed;* secondly, those in which a gas is evolved at the temperature under a red heat; and, finally, those reactions in which a gas is evolved in the action of a liquid on a solid. The important reactions which can be examined in the apparatus are so numerous that its range is hardly exceeded by any other lecture apparatus. In most cases the complete analysis may be realised in a few moments by a volumetric analysis of the product remaining in the heating-tube or decomposition flask. Thus, in the analysis of potassium chlorate, the chloride remaining in the heating-tube can be washed into a beaker and a volumetric chloride estimation made; or, in the investigation of the action of chlorhydric acid on metallic zinc or calcium carbonate, a known volume of standard acid taken and the undecomposed acid determined by titration.

It is often desirable to keep a small volume of a gas for subsequent investigation—a purpose for which the following simple gasometer has been found useful:—Two small bottles of about 50 c.c. each, are fitted with double-bored rubber corks, and connected by a glass tube bent in the form of a syphon. The limb of the syphon, which is in the flask used as gasometer, is somewhat longer than the other limb. Through the second hole of that bottle a bent delivery tube, provided with a small glass stopcock, barely passes, and a small bent tube passes through the cork of the second bottle. For use, the gasometer and syphon are filled with mercury, and the end of the delivery tube then connected with the generating flask.† A small quantity of mercury is allowed to remain in the gasometer. The apparatus works, to a certain extent, automatically. On opening the stopcock of the charged gasometer, mercury will pass over until it is on a level in both bottles, and the remaining half can be expelled by applying pressure to the bent tube of the second bottle. A well-constructed apparatus will keep a gas for weeks without an appreciable change.

I wish finally to call attention to a slight modification of Hofmann's well-known V tube, which permits the collection of both the products of decomposition, and can, therefore, be used for quantitative analysis. On the upper side of the bend of the tube a glass tube is connected, which is an inch higher than the limbs of the V tube (Fig. 4). The limbs are graduated in five or six equal parts;

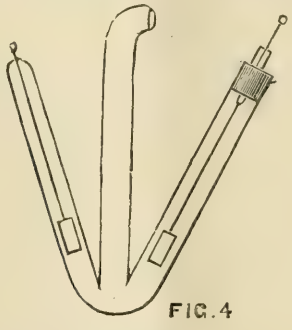


FIG. 4

those on the open limb beginning, not at the open end, but about one half an inch from it. For use, the apparatus is filled with liquid, and the cork, through which a glass tube with platinum electrode passes, is pressed into the open limb until it reaches the first graduation. The displaced liquid flows out through the middle limb, which is conveniently connected with a rubber tube. Ungraduated Ure's eudiometers, provided with a short horizontal tube on the lower side of the bend, or on the upper side and bent downwards, make a cheap and efficient substitute for Hofmann's lecture-eudiometer, especially for students' use in the laboratory.—*American Chemical Journal*, vol., v., No. 5.

* No experiments have been made as yet on reduction of heavy metallic oxides in hydrogen, under similar conditions; but I do not doubt that sufficiently accurate results would be obtained.

† A more advantageous form is to have the delivery tube connected to the neck of the gasometer, directly under the rubber cork.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MANGANESE.

REJECTING the early experiments of J. Davy and of Arfvedson, the first determinations of the atomic weight of manganese which we encounter are those of Turner† and of Berzelius.‡ Both of these chemists used the same method. The chloride of manganese was fused in a current of dry hydrochloric acid, and subsequently precipitated with a solution of silver. From the subjoined weighings I calculate the ratio given in the third column between $MnCl_2$ and 100 parts of AgCl:—

			Berzelius.
4·20775 grms.	$MnCl_2$ = 9·575 grms.	AgCl.	43·945
3·063 ,,	= 6·96912 ,,		43·950
		Turner.	
12·47 grains	$MnCl_2$ = 28·42 grains	AgCl.	43·878

Mean 43·924 ± 0·015

Hence the molecular weight of $MnCl_2$ is 125·662 ± 0·045.

Many years later Dumas‖ also made the chloride of manganese the starting point of some atomic weight determinations. The salt was fused in a current of hydrochloric acid, and afterwards titrated with a standard solution of silver in the usual way. 100 parts of Ag are equivalent to the quantities of $MnCl_2$ given in the third column:—

3·3672 grms.	$MnCl_2$ = 5·774 grms.	Ag. 58·317
3·0872 ,,	5·293 ,,	58·326
2·9671 ,,	5·0875 ,,	58·321
1·1244 ,,	1·928 ,,	58·320
1·3134 ,,	2·251 ,,	58·321

Mean 58·321 ± 0·001

Hence $MnCl_2$ = 125·594 ± 0·011. This, combined with Berzelius and Turner's figures, gives $MnCl_2$ = 125·598 ± 0·011. And Mn = 54·858 ± 0·031.

An entirely different method of investigation was followed by v. Hauer,§ who, as in the case of cadmium, ignited the sulphate in a stream of sulphuretted hydrogen, and determined the quantity of sulphide thus formed. I subjoin his weighings, and also the percentage of MnS in $MnSO_4$ as calculated from them. (See Table next column).

This method of v. Hauer's, which seemed to give good results with cadmium, is, according to Schneider,¶ inapplicable to manganese; for the reason that the sulphide of the latter metal is liable to be contaminated with traces of oxysulphide. Such an impurity would bring the atomic weight out too high. The results of two different

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Trans. Roy. Soc. Edin.*, 11, 143. 1831.

‡ "Lehrbuch," 5th Ed., 3, 1224

‖ *Ann. Chem. Pharm.*, 113, 25. 1860.

§ *Journ. f. Prakt. Chem.*, 72, 360. 1857.

¶ *Poggend. Annal.*, 107, 605.

4·0626 grms.	$MnSO_4$ gave	2·3425	MnS.	57·660 per cent.
4·9367	,,	2·8442	,,	57·613 ,,
5·2372	,,	3·0192	,,	57·649 ,,
7·0047	,,	4·0347	,,	57·600 ,,
4·9175	,,	2·8297	,,	57·543 ,,
4·8546	,,	2·7955	,,	57·585 ,,
4·9978	,,	2·8799	,,	57·625 ,,
4·6737	,,	2·6934	,,	57·629 ,,
4·7240	,,	2·7197	,,	57·572 ,,

Mean 57·608 ± 0·008

Hence Mn = 54·785 ± 0·031.

processes, one carried out by himself and the other in his laboratory by Rawack, are given by Schneider in this paper.

Rawack reduced manganoso-manganic oxide to manganous oxide by ignition in a stream of hydrogen, and weighed the water thus formed. From his weighings I get the values in the third column, which represent the Mn_3O_4 equivalent to 1 grm. of water :—

4·149 grms.	Mn_3O_4 gave	0·330	H_2O.	12·5727
4·649	,,	0·370	,,	12·5643
6·8865	,,	0·5485	,,	12·5552
7·356	,,	0·5855	,,	12·5636
8·9445	,,	0·7135	,,	12·5361
11·584	,,	0·9225	,,	12·5572

Mean 12·5582 ± 0·0034

Hence Mn = 53·911 ± 0·026.

Here the most obvious source of error lies in the possible loss of water. Such a loss, however, would increase the apparent atomic weight of manganese; but we see that the value found is much lower than that obtained either by Dumas or v. Hauer.

Schneider himself effected the combustion of manganous oxalate with oxide of copper. The salt was not absolutely dry, so that it was necessary to collect both water and carbon dioxide. Then, upon deducting the weight of water from that of the original material, the weight of anhydrous oxalate was easily ascertained. Subtracting from this the CO_2, we get the weight of Mn. If we put CO_2 = 100, the quantities of manganese equivalent to it will be found in the last column :—

Grms.		Grms.		Grms.		
1·5075	oxalate gave	0·306	H_2O and	0·7445	CO_2.	61·3835
2·253	,,	0·4555	,,	1·1135	,,	61·4291
3·1935	,,	0·652	,,	1·5745	,,	61·4163
5·073	,,	1·028	,,	2·507	,,	61·3482

Mean 61·3943 ± 0·0122

Hence Mn = 53·904 ± 0·014.

This result agrees beautifully with the value calculated from Rawack's experiments.

Now to combine the four independent values which we have thus far obtained :—

From $MnCl_2$	Mn = 54·858	± 0·031
,, $MnSO_4$	,, 54·785	0·031
,, Mn_3O_4	,, 53·911	0·026
,, MnC_2O_4..	,, 53·904	0·014
General mean ..	,, 54·128	0·011
If O = 16	,, 54·251	

The considerations already cited, however, go to show that this general mean must be slightly affected by some plus constant error. It is probable, therefore, that a more correct figure will result from rejecting the first and second values in the above combination, and taking the data furnished by Rawack and Schneider alone. Combining their figures we get as follows. Mn = 53·906 ± 0·012. Or, if O = 16, Mn = 54·029.

Since the foregoing calculations were made Dewar and Scott* have reported the following experiments. From the complete analysis of silver permanganate, putting Ag = 108 and O = 16, they find in three estimations Mn = 55·51, 54·04, and 54·45. From the analysis of pure MnO_2, made from the nitrate, Mn = 53·3 to 53·6. Up to the date of writing a detailed account of the methods employed has not been published.

The following additional note has been communicated by the author :—

Since the foregoing was printed, new determinations of the atomic weight of manganese have been made by Marignac,† and the details of Dewar and Scott's work have appeared.‡

Dewar and Scott, without reporting particulars, state that experiments upon $MnCl_2$ give a value for Mn of 54·91 and others upon $MnBr_2$ make Mn = 54·97. Six reductions of $AgMnO_4$, by heating in hydrogen, give in mean a residue of Ag + MnO, equal to 78·835 per cent, ± 0·017. Hence Mn = 54·968 ± 0·497. Ten titrations of $AgMnO_4$ with KBr give in mean 190·647 ± 0·114 part of the former salt as equivalent to 100 of the latter. Hence, recalculated, Mn = 54·936 ± 0·143.

Marignac, by converting pure MnO into pure $MnSO_4$, found 100 parts of the former equivalent to 212·73 ± 0·0279 of the latter. Hence Mn = 54·891 ± 0·0228.

The foregoing results, combined with the results of Dumas, Berzelius, Turner, and v. Hauer, give a general mean of Mn = 54·855 ± 0·016. If O = 16, this becomes Mn = 54·981. The higher value for manganese may now be considered established.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, January 26, 1884.

Prof. Clifton, President, in the Chair.

New Member—Fung Yee, Secretary to the Chinese Legation.

Prof. Clifton announced that Lady Siemens had presented a portion of the late Sir William Siemens's library to the Society.

The meeting, which was at first a special meeting to consider the resolution that it is expedient for the Past Presidents of the Society to be permanent Vice-Presidents, having agreed to this resolution, was constituted an ordinary meeting, and

Profs. Ayrton and Perry described and exhibited their new ammeters and voltmeters, also a non-sparking key. The well-known ammeters and voltmeters of the authors used for electric light work are now constructed so as to dispense with a constant and give the readings in Ampères and Volts without calculation. This is effected by constructing the instruments so that there is a falling off in the controlling magnetic field, and a considerable increase in the deflecting magnetic field. The deflections are thus made proportional to the current or E.M.F. measured. The ingenious device of a core or soft iron pole-piece, adjustible between the poles of the horse-shoe magnet, is used for this purpose. By means of an ammeter and voltmeter used conjointly, the resistance of part of the circuit, say a lamp or heated wire, can be got by Ohm's law. Profs. Ayrton and Perry's non-sparking key is designed to prevent sparking with large currents. It acts by introducing a series of resistance coils determined experimentally one after the other in circuit, thereby cutting off the spark.

* *Nature*, Sept. 15, 1881, p. 470.
† *Arch. des Sci. Phys. et Nat.*, (3), 10, 21.
‡ Chemical News, xlvii., 98.

Dr. C. R. Alder Wright, F.R.S., read a paper on the "*Electromotive Force set up during Inter-diffusion*," being the result of experiments made by himself and Mr. C. Thompson, to determine the effect of varying densities of solutions used in voltaic cells on their E.M.F.s. The observations were made by constructing the cells of pure materials and opposing them, so that the differential E.M.F.s could be measured by galvanometer or quadrant electrometer, when solutions of different densities were employed. The following general conclusions were reached:—(1) In any two-fluid cell containing solutions of two metallic salts and plates of the respective metals contained therein, an increase of strength in the solution surrounding the plate acquiring the higher potential, in virtue of the normal action of the cell, causes an increment in the potential difference between the two plates: and the opposite effect is produced by an increment in the strength of the solution surrounding the other plate. (2) A law of summation holds, expressible thus: The effect of the sum of a series of changes in the strengths of the solutions in a two-fluid cell is equal to the algebraic sum of the effects of each change severally. The author considered this law very fully, and pointed out that "diffusion cells" act at least partly after the fashion of thermo-couples, transforming into electric energy a certain amount of sensible heat.

NOTICES OF BOOKS.

Principles of Theoretical Chemistry, with special reference to the Constitution of Chemical Compounds. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. Philadelphia: Henry C. Lea's, Son, and Co., 1883 (2nd Edition).

To Professor Remsen every conscientious student of chemistry must feel himself indebted for the care and labour which the author has given to the writing of this little manual and the impartial manner in which the principles of the science are treated. After cramming into one's head heaps of formulæ and equations, hypotheses rigidly stereotyped with every care to make them look like laws, one experiences a sense of relief on taking up this book and following the author's discussions of the principal hypotheses which are at present considered as the foundation stones of the science of chemistry. How very few students take the trouble to reason out for themselves the exact connections between facts and hypotheses, and the readiness with which they accept hypotheses without fully recognising the facts upon which they are based every teacher knows too well, and it is, therefore, highly necessary that for the sake of such students a work of the present character should be written in order to show how much we do not know, and upon how very narrow a foundation the hypotheses of the science rest. In his preface the author tells us that his object has been to point out the exact connection between the facts known to us and the hypotheses, and in the same place he only reiterates the experience of other teachers but too truly when he says that "Much harm has been done the science by a too free use of hypotheses by those who were ignorant of the facts which suggest them. This has been and is particularly noticeable in connection with the use of structural or constitutional formulas. It is heart-rending to see a tyro in chemistry using these formulas with a freedom that might well appal one who knows their true meaning. An experience of years with students of chemistry has led me to the conclusion that the formulas are generally used without understanding." This state of affairs it might be urged must be due to the teachers themselves or more justly to the writers of our text-books who follow one general plan of a mere statement of facts and embellish their works with multitudinous formulæ, leaving it to the student himself to co-ordinate the facts with the hypotheses.

Treatises like the one now before us, which discuss the hypotheses in chemical science, already exist, such, for instance, as the excellent work of Lother Meyer; but so far as our experience goes none of them are so admirably suited to the student in his earlier stages of instruction as serving to keep him in check in his reckless acceptance of hypotheses, and for training him to think of the facts in relation to the hypotheses which may lead him to see that the aim and end of all chemistry is not the determination of a formula or equation or the compound formed by the action of x upon y, but that beyond these things—almost trivialities now—there are far higher matters in the science which demand investigation.

It is needless for us to give a detailed account of the contents of Prof. Remsen's little book, as all the principal hypotheses in the science are discussed in an impartial manner and as objectively as possible, and the arrangement and style of the matter all that could be desired. In the first part we have a general discussion of atoms and molecules; the three first chapters of this section being upon the atomic hypothesis, atomic weights, how these values are determined in relation to each other, the bearing of Gay-Lussac's investigations and Avogadro's speculations upon the subject, and the facts obtained by the study of the specific heats of the elements in connection with atomic weights. Then follow two chapters, one on the properties of the elements as functions of their atomic weights in which Mendelejeff's and Meyer's arrangements into periods are discussed, and the other on valence or atomicity of the elements in which the subject is considered from all points. In the second part, on the constitution or structure of chemical compounds, this wide field is gone over with considerable minuteness, and is certainly a valuable section for the student of the present period,—"a period of chemistry which may be fairly called one of formula worship,"—who is so apt to look upon a formula of a compound as representing its internal structure or mode of arrangement of its contained elements, as showing by the proofs that are brought forward in support of the formulæ upon what slender grounds they rest. "A study of the preceding chapters on constitution will show that no absolute meaning is to be attached to the word. Constitutional formulas are those which suggest certain reactions and recall analogies. The formula suggests possibilities; it may not represent realities."

As an exposition of the hypotheses in use in chemistry this little book is sure to take a high rank, and we cannot but think that its study, in conjunction with one of the usual text-books of facts, by the elementary student, would prove of very great service to him, and would also be of assistance to those teachers who lay so much stress upon the value of formulæ for purposes other than as aids to the memory.

The Year-Book of Photography for 1884. Edited by H. Baden Pritchard, F.C.S. London: Piper and Carter.

We have here what might be well termed the photographer's "Whitaker" for the year 1884, which, containing a complete calendar for the year, notices of the various photographic societies throughout the country, and the principal ones on the continent and in America, together with a heap of information such as every photographer requires, hints on developing, printing, lighting, and posing, and numberless other subjects, forms a complete epitome of the present state of photography. It would be beyond our scope to give even the merest outline of the contents of this almanac, or name the well-known authorities who have helped to produce this work under the able editorship of Mr. Pritchard, but suffice it to say that no one will take up the volume without gaining some information or hint that may be of service to him.

Together with a retrospect of the photographic progress made during the year that has just passed away, a number

of contributions that will prove of use both to amateurs as well as to professionals, and many pages of instructive and amusing jottings from the pen of the editor, a portion of the book is devoted to standard formulæ with short descriptions for working the preparations; tables for the conversion of grammes into ounces and grains, and a short epitome of qualitative chemical analysis sufficient to suit the purposes of the photographer.

Considering the large amount of valuable information that has been compressed into this little book we think no photographic studio could be considered complete without a copy.

The Extra Pharmacopœia of Unofficial Drugs. By William Martindale, F.C.S., and W. W. Westcott, M B. Lond. Second Edition. London: H. K. Lewis, 1884.

In a neat and handy little volume we have here a valuable dictionary of unofficial drugs and chemical and pharmaceutical preparations. Considering that it is about sixteen years since the publication of the last British pharmacopœia and the progress that has been made in medical science by the introduction of many valuable new drugs and methods of treatment during this interval, there are sufficient reasons for the publication of this extra pharmacopœia. These new drugs, their uses, and the doses employed are described in this little manual, viewed specially from a pharmaceutical and medical aspect, abundant references being given to the original sources of the information. The usual system of weights is employed throughout of ounces, grains, drachms, &c., although the author thinks rightly that much advantage would be derived by the introduction of the metric system into pharmacy. With a very copious index and posological table of the contents, together with a therapeutic index of diseases and symptoms, this little book cannot fail to be of much service to the profession. The fact that the first edition was exhausted in a few weeks says much for the quality of the compilation and the desirability of such a dictionary among medical men.

The Chemical Effect of the Spectrum. By Dr. J. M. Eder, Professor at the Technische Hochschule, Vienna. Translated and Edited by Captain W. de W. Abney, R.E., F.R.S. London: Harrison and Sons, 1883.

Looking back over the last 60 years since the days when Nièpce was quietly working out his plans for drawing pictures by light and struggling to bring his invention before the notice of the public, and considering the beautifully artistic productions that are now to be had for a few pence, one cannot help admiring the wonderful amount of labour that has been expended and the skill that has been brought to bear upon the subject. Empirical experimentation, and much of it, has been the source of all the success of the photograpic student, and a glance through this pamphlet shows but a fraction of the vast amount of labour that has been expended in bringing up Nièpce's first crude method of photography to the perfection it has now obtained. Dr. Eder's small book has already appeared in English in the *Photographic Journal* for 1881 and 1882, translated from the French copy, and from which journal the present is a reprint. It is certainly desirable, however, that the work should be published in a separate form, as its principal value depends on its excellency as a book of reference to the experimental work of others. As the title of the pamphlet indicates, the contents treat in the main of the action of light on chemical compounds, as the salt of silver, iron, uranium, &c., sensitisers and dyed films, in which the results obtained by different experimenters are given with references to their publications, which will render the book a valuable addition to photographic literature.

It might have been well, we think, to have given a fuller index with the names of the workers whose observations are quoted in the body of the book, as for a work of reference this is certainly desirable.

CORRESPONDENCE.

RAPID FILTRATION.

To the Editor of the Chemical News.

Sir,—I have devised a more simple means for inducing rapid filtration in analytical work than any I have yet seen mentioned.

The filter is prepared, and supported at the point by a cone, as required by the suction methods, in a funnel, which it is best to have with its edges ground level, and held in any firm support.

The device is simply to have a glass plate about 6 inches in diameter and 1 inch thick, which has a $\frac{1}{4}$-inch thick soft rubber disc of the same size as the glass cemented to its surface. There is a hole through the centre of the glass and rubber plate. This heavy plate is large enough to cover any size funnel likely to be used, and will make a tight joint by its rubber side with the funnel, either through its own weight or if pressed down by the hand. Through its central hole air is forced in from a rubber tube connected with one of Fletcher's excellent foot-bellows, to *any* desired pressure. To prevent the air thus blown in from agitating too much the fluid contents of the filter, a piece of very thin sheet rubber, something larger square than the hole, is fastened over it by its four corners, having pins passed slantingly through them into the rubber plate beneath it. This prevents the air from being blown straight down into the filter, but makes it spread out sideways.

This method leaves free and easy access to both the filtrate and the filter by the simple lifting off of the plate from the funnel, is simple of application, and not likely to be out of working order when wanted for use. The pressure is under perfect control.—I am, &c.,

B. F. Davenport, State Analyst.

Boston, Mass., Jan. 9, 1884.

VOLUMETRIC ESTIMATION OF MANGANESE.

To the Editor of the Chemical News.

Sir,—I am very glad to see that the method mentioned by me in the Chemical News, vol. xlix., p. 9, is used in other laboratories, and is found to work well; I should not have called attention to such a simple matter, but that no one I consulted knew of that particular method being in use elsewhere. I do not, however, prefer Mr. Atkinson's method (vol.xlix., p. 25) of estimating the silicon to the one we use; and it surprises me to hear he finds the least difficulty in filtering the solution of Mn and Fe from the insoluble SiO_2. We have none whatever, as, if one is doing six at once, the first is through the filter before the sixth can be got into the funnel. Neither does any Fe_2Cl_6, which is always formed, make any difference. We wash with hot water containing about 5 per cent HCl, and find our silica quite white and free from iron. We are the happy possessors of a good stink-cupboard, and as the HCl is evaporated in it the fumes cause no annoyance; but would not Mr. Atkinson prefer HCl vapour to H_2SO_4 vapour, if you *must* have one or the other? I should.

However, we will try the sulphuric acid method practically, and if we find any improvement on our present ways, either in time or accuracy, it will be adopted, as I am always very glad to learn.—I am, &c.,

A. H. Holdich.

Wigan Coal and Iron Co, Jan. 21, 1884.

ON THE DETECTION OF ALBUMEN IN URINE.

To the Editor of the Chemical News.

SIR,—In the letter of Prof. Mason, of Troy, New York, which appeared in the CHEMICAL NEWS, vol. xlviii., p. 304, he suggests that, as the acetic acid which I use cannot prevent the precipitation of phosphate of iron, the test is therefore useless for detecting albumen in urine.

Since my letter appeared, I have gone over the subject again with identically the same results.

If Prof. Mason will experiment with a 2 per cent solution of sodium phosphate (from 2-3rds to 3-4ths the P_2O_5 in urine is combined with either Na or K), to which he will add a saturated solution of sodium chloride, he will find that a white precipitate will form; on the addition of acetic acid this will re-dissolve. If to this solution he adds an acid Fe_2Cl_6 solution no visible precipitate will be formed till after the lapse of at least two hours, and if the sodium phosphate solution be still more dilute it may not become visible before twelve hours (see "Fresenius's Qualitative Analysis," pp. 154, 155); while, on the other hand, albumen will be precipitated almost immediately. Prof. Mason is correct in stating that acetic acid will not prevent the ultimate precipitation of phosphate of iron, but it retards it sufficiently for practical purposes.—I am, &c.,

A. R. HASLAM.

Dublin, January 22, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chemie.
Tome viii., December, 1883.

A New Process for the Determination of Cinchonas.—A. Petit.—Prollius has shown that on treating 40 grms. of cinchona bark with 800 grms. of a liquid composed of—

Alcohol at 95°	67 parts,
Sulphuric ether at 65°	733 ,,

to which are added 32 grms. of ammonia, and shaking the whole up together, all the alkaloids of the bark are easily brought into solution. Comparative trials have shown that the bark must be finely powdered, and that by shaking every five minutes the exhaustion is as complete in an hour as after maceration for five or six hours. 600 grms. of the liquid are decanted, which represent three-fourths of the bases of the portion operated upon, or in other words the bases present in 30 grms. of the sample. There is then added a solution containing one-fourth of its weight of sulphuric acid, and in such a quantity that the aqueous liquid which separates may be distinctly acid. In general 22 c.c. are sufficient. This aqueous liquid contains all the alkaloids previously contained in the ethereal solution, and is decanted off by means of a special funnel. The ethereal liquid is again shaken up with 5 c.c. of acid and 15 c.c. of water, the aqueous solution being then decanted, and added to the former quantity. This liquid is then heated in the water-bath to expel dissolved ether, diluted with twice its volume of water, and precipitated with an excess of caustic soda. On stirring with a glass rod and heating slightly in the water-bath,—if necessary—the alkaloids collect together in a mass, which is placed in a stove and dried at 100°. If the liquid is not absolutely clear it is filtered through a tared filter, and the difference of weight is added to that of the alkaloids which have collected in a mass. We have thus the total weight of the alkaloids contained in 30 grms. of the sample. They are then dissolved in a slight excess of sulphuric acid, and there are added 25 c.c. of ether at 65°, and 5 c.c. of ammonia, and the whole is shaken up. The alkalies soluble in ether dissolve in that liquid, and are removed by decantation. The original solution is again shaken up with 10 c.c. of fresh ether, which is then decanted off, and added to the former quantity. After being let stand for fifteen minutes, so that the alkaloids which are sparingly soluble in ether may be deposited, it is then decanted, and agitated with 10 c.c. of water containing 5 per cent of sulphuric acid, and again, after separation, with 5 c.c. of the same acid. These two liquids are poured together, and it is ascertained that they are distinctly acid. The liquid is made up to 25 c.c., saturated with ammonia diluted to one-fifth, and raised to a boil. When the reaction is very feebly alkaline the heat is withdrawn. Quinine sulphate then separates out in the form of fine crystalline needles. When completely cold they are collected on a tared filter, washed with a solution of quinine sulphate (saturated in the cold), and dried in the stove at 100°; drying until the weight becomes constant. From the dry quinine sulphate thus obtained from 30 grms. the proportion of hydrated sulphate corresponding to 1 kilo. is calculated. In order to ascertain if the quinine sulphate is sufficiently pure it is dissolved in sulphuric acid, and the solution is examined with the polariscope. If the rotatory power does not approach sufficiently near to $-238{\cdot}3°$ for the ray D, and the temperature 15°, it is purified by a new treatment with ether and ammonia, and by a second crystallisation.

Poisoning with Chromic Acid.—M. Lacassagne.—An account of the death of two men who had swallowed a wine glass full of an acidulated solution of potassium dichromate used for supplying a "Grenet" battery, and which from its colour they had mistaken for Malaga wine. The two together seem to have swallowed about 5 grms. of the dichromate.

Examination of Spots produced by the Washings of a Gun recently used.—M. Masse.—An Arab, suspected of having fired at and wounded one of his relatives, accounted for certain black spots found on a linen cloth in his possession as having been caused by mulberry stains. The spots were not removed by cold water, and under the microscope they appeared to consist of small black irregular grains. On the other hand, mulberry stains gave a violet colour to cold water, and on microscopic examination showed vegetable cellules containing a violet matter, and granules of chlorophyll. Hence the experts decided that the stains on the garment of the accused could not have been produced by the juice of fruits.

Detection of Methylic Alcohol in Ethylic Alcohol.—E. van de Vivère.—The author distils the suspected matter in the water-bath, heating as long as volatile products pass over. These are again distilled in the water-bath over pure dry sodium carbonate, so as to obtain the alcohols in the anhydrous state. The volume of the mixture is then taken. In one portion the presence of methylic alcohol is ascertained. The other part is weighed, and mixed with an equal weight of dry calcium chloride. After being left in contact for twenty-four hours it is distilled in the water-bath. The methylic alcohol remains in combination, whilst the other volatile products pass over. When all the volatile matter has thus been driven off there is added to the fixed residue a quantity of water equal to the weight of the chloride, and it is redistilled, we obtain then the methylic alcohol more or less diluted with water, but its quantity can be exactly determined.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 11.

Production Cost of Farmyard Manure.—A. Dettweiler.—From seemingly exact observations made on four farms, the yearly produce of a cow is 260 cwts. dung yearly, and if the value of the mineral plant-food is taken

at 34·84s., the 117 lbs. of nitrogen in the dung cost at Wintersheim 4·87s., at Laubenheim 13·2s., and Nierstein 0·0s., and at Guntersblum 69·9s. These figures have to be increased by rent, interest on capital sunk, &c.

Manurial Experiments on the Experimental Farm, Peterhof, near Riga.—Prof. W. Knieriem.—Superphosphate and precipitated phosphate of lime were found nearly equal in their action, as it has been also observed elsewhere in soils very rich in humus.

Cause of Differences in the Analysis of Superphosphates.—Prof. M. Märcker.—Boxes of zinc, sheet-iron, tinned iron, &c., are not admissible for sending samples of superphosphate, or for preserving them for reference. In a sample of superphosphate which contained originally 20·09 per cent soluble phosphoric acid there became insoluble in five days 0·38 per cent, and in twenty-five days 1·43 per cent of phosphoric acid.

Researches on the Influence of the Bulk of the Soil upon the Development of the Roots of certain Cultivated Plants.—Prof. Hellriegel.—A physiological paper.

Comparative Value of Factitious and Genuine Butter.—Prof. Mayer and P. Udall.—The author finds in a series of comparative experiments that a larger percentage of genuine butter is assimilated than of "oleomargarine." The difference, though unimportant for healthy adults, may prove of moment to sick persons, convalescents, and young children. The taste of the artificial butter was found under certain circumstances tallowy. Udall points our certain possible sources of error in Mayer's experiments, which, he thinks, may have affected the result unfavourably as regards the digestibility of factitious butter. He doubts, however, the harmlessness of the latter article, as bad fat may have been employed in its preparation.

Saccharine and its Derivatives.—Dr. H. Kiliani, Prof. Liebermann, and Prof. Scheibler.—An account of saccharone and saccharonic acid.

Determination of Sugar in Beets.—Dr. K. Stammer and Dr. E. Sostmann.—The authors find that the four different methods of determination by the polarising process do not give accordant results.

MEETINGS FOR THE WEEK

MONDAY, Feb. 4th.—Medical, 8.30.
—— London Institution, 5.
—— Royal Institution, General Monthly Meeting, 5.
—— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.
—— Society of Chemical Industry, 8. "The Disposal of Sewage Sludge," by C. C. Hutchinson; "The Porter-Clark Process," by J. H. Porter; "Keiselguhr and its Technical Applications," by Mr. Haacke.

TUESDAY, 5th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.

WEDNESDAY, 6th.—Society of Arts, 8. "Suggestions on the Rehousing of the Poor, and Reconstruction of Central London," by William Westgarth.
—— Geological, 8.
—— Pharmaceutical, 8.

THURSDAY, 7th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
—— London Institution, 7.
—— Chemical, 8. "On the Influence of the Temperature of Distillation on the Composition of Coal-Gas," by L. T. Wright; "Researches on Secondary and Tertiary Azo-compounds, No. II.," by R. Meldola.

FRIDAY, 8th.—Royal Institution, 8. "The Darwinian Theory of Instinct," by G. J. Romanes, at 9.
—— Astronomical, 8. (Anniversary.)
—— Quekett Microscopical Club, 8.

SATURDAY, 9th.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.
—— Physical, 3. Annual General Meeting.

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1263.

ON THE

ELECTROLYSIS OF DILUTE SULPHURIC ACID AND OTHER HYDRATED SALTS.*

By J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, Lecturer on Chemistry in Dulwich College.

On the 1st of March last a communication was presented to the Royal Society by Professor Frankland, in which, among other things, the reactions we had described as taking place in the charging and discharging of secondary batteries were confirmed. The author expressed these reactions, however, by formulæ founded on the electrolysis, not of H_2SO_4, but of hexabasic sulphuric acid, H_6SO_6, in accordance with the views of Bourgoin.

The point of difference is a small one, but it led us to look into the papers of Bourgoin, and to examine the evidence upon which his views were based. The French chemist (*Ann. de Chimie*, 1868) treats of the electrolysis of sulphuric acid merely as an illustration of his method for determining the composition of hydrated salts in solution generally. This method consists in electrolysing a given solution in a divided cell, analysing the liquid in each compartment at the close of the experiment, and, in the case of dilute sulphuric acid, collecting the hydrogen set free. In the case of a solution of sulphuric acid, of course, the positive compartment may be expected to increase in strength as a consequence of the electrolytic action, and the negative compartment to decrease in strength in the same degree. Bourgoin calls the increase of the acid in the positive compartment α, and concludes that 2α represents the amount of sulphuric acid electrolysed. This conclusion rests on the well-known theoretical views of Grotthus, and, did his theory express all that goes on in the electrolytic process, the method would readily discriminate between the actions represented by the following formulæ —

	Before Electrolysis.		After Electrolysis. Positive pole.	Negative pole.
(1.)	SO_3H_2O	=	SO_3+O	H_2
(2.)	SO_33H_2O	=	SO_3+O_3	H_6
(3.)	SO_3nH_2O	=	SO_3+O_n	H_{2n}

But it was pointed out by Reuss, as far back as 1807, that when electrolytic action occurs across a permeable diaphragm, a portion of the liquid may travel from the positive to the negative compartment of the compound cell by what is now call electrical endosmose. Daniell and Miller (*Phil. Trans.*, 1844) pointed out that in electrolytic action there was also an unequal transference of the ions. It is evident that each of these actions must introduce additional terms into the formula with which Bourgoin worked. Moreover, Daniell (*Phil. Trans.*, 1839) investigated the electrolysis of sulphuric acid of very different strengths by a similar method, and on a review of the evidence (*Phil. Trans.*, 1840) concluded that for each equivalent of hydrogen liberated, the acid which passed across the diaphragm was not more than one-fourth nor less than one-fifth of an equivalent. Most of his experiments incline to the former. Did 2α, therefore, represent the amount of sulphuric acid electrolysed, it would appear from his results that *tetra-*, and not *hexa-*, basic sulphuric acid was decomposed by the current. Again Hittorf, in 1853 (*vide* Wiedemann's "Electricity," vol. ii., p. 589), observed that for one equivalent of hydrogen liberated, the amount of sulphuric acid which was found in the positive compartment varied, but not regularly, with the strength of the acid. These discrepancies, both of observation and deduction, led us to make some experiments on the subject ourselves.

The apparatus we employed consisted of a U-shaped tube of about 70 cub. centims. capacity, having a stop-cock in the centre of the horizontal part. The vertical parts of the apparatus were divided into millimetres, and the hole in the stop-cock packed with asbestos. We found that the closeness of the packing could be so nicely adjusted as to allow neither mechanical admixture of the fluids, on the one hand, nor electrical endosmose on the other. In our experiments we varied the current density, and, unlike Bourgoin (*Ann. de Pharm.*, vol. xv.), found that the increase of sulphuric acid in the positive compartment per equivalent of hydrogen set free decreased along with the decrease in the current density. The strength of acid was 4·2 per cent. The results are set out in the annexed table:—

Current in milli-ampères.	Time in hours.	Increase of sulphnric acid in positive compartment for one part of hydrogen set free.
32·8	20	9·17
33·4	6	9·5
72·3	2·5	10·3
72·7	2	9·4
106	2	11·0
117	2·5	10·5
215	1·5	12·05
220	1	12·04
229	2	12·31

It is necessary also to bear in mind the remarkable phenomenon, called by the Germans "Wanderung der Ionen." Daniell long ago described an experiment in which he placed dilute sulphuric acid in the positive compartment and a solution of sulphate of copper in the negative. He found that when 15·5 grs. of copper had been deposited on the negative electrode there were 23 grs. of sulphuric acid in the same compartment. Now, as 15·5 grs. of copper are equivalent to 24 grs. of sulphuric acid, and as Bourgoin's formula allows for the formation of only half an equivalent of sulphuric acid, that is 12 grs., it is evident that there was a considerable accumulation of that substance unaccounted for. In two similar experiments made with our apparatus, we obtained for 0·147 and 0·125 grm. of deposited copper respectively 0·209 and 0·180 grm. of free sulphuric acid. The half equivalents would be 0·114 and 0·097 grm. respectively. The excess of acid in all these cases is due to the "unequal transference of the ions." If both compartments had been filled with sulphuric acid, some similar transference would doubtless have taken place, in addition to what is expressed in Grotthus's chain of decomposition.

We conclude, therefore, from our own results, as well as from those of previous experimenters, that the method employed is incapable of determining whether it is H_2SO_4 or some hydrate which yields to the current.

Copper Sulphate.

A careful examination of the chemical changes which accompany the electrolysis of a solution of copper sulphate appeared, however, capable of throwing additional light on the value of this electrolytic method for ascertaining the composition of hydrates in aqueous solution. It is well known that water forms with $CuSO_4$ a definite hydrate, $CuSO_45H_2O$. The anhydrous salt is white, the hydrate blue. It is reasonable to suppose that the blue solution of this salt contains molecules of this or of some higher hydrate. Now, if in the electrolytic process the water of hydration suffers decomposition along with the $CuSO_4$, the primary chemical changes might be expected to be—

$$\text{(A.)}\quad CuSO_45H_2O = \overbrace{SO_3+O_6}^{\text{Positive pole.}} \quad \overbrace{Cu+5H_2}^{\text{Negative pole.}}$$

* A Paper read before the Royal Society, January 17th, 1884.

But, if the water of hydration takes no more part in the electrolysis than the water of solution does, then the chemical changes would manifestly be—

$$\text{(B.)}\quad CuSO_4 = \overbrace{SO_3+O}^{\text{Positive pole.}} \quad \overbrace{Cu}^{\text{Negative pole.}}$$

Of course the collateral action—

$$H_2O = \overbrace{O}^{\text{Positive pole.}} \quad \overbrace{H_2}^{\text{Negative pole.}}$$

might also take place, but this would occur only with currents of considerable density. The method is obviously capable of discriminating between these two actions, even supposing that a considerable quantity of the electrolyte travelled unchanged from one compartment of the apparatus to the other. For, in the first case, either free hydrogen would be liberated at the negative pole, or free acid formed in the negative compartment, equal to five-sixths of the total copper deposited; the free acid, and the five-sixths of the total copper, to which it is equivalent, being produced by the chemical action—

$5H_2+5CuSO_4=Cu_5+5H_2SO_4$; equation A becoming—

$$CuSO_4,5H_2O+5CuSO_4 = \overbrace{SO_3+O_6}^{\text{Positive pole.}} \quad \overbrace{Cu_6+5H_2SO_4}^{\text{Negative pole.}}$$

On the other hand, if the action was in accordance with B there would be only a deposition of copper on the negative electrode, and no formation of free acid in the negative compartment. In the annexed table the results and particulars of several experiments are set out. In each experiment 25 cub. centims. of a 10 per cent solution of sulphate of copper were placed in the negative and positive compartments respectively of the apparatus. The positive electrode consisted of a platinum wire, and the negative of a weighed strip of metallic copper:—

Experiment.	Time in hours.	Free sulphuric acid. Pos. Compart.	Neg. Compart.
I.	1½	0·0766	nil.
II.	2	0·0936	nil.
III.	3	0·1868	0·0191
IV.	3	0·1501	0·0204
V.	3	0·2442	0·0237
VI.	3	0·2546	0·0372

In none of these experiments was there any trace of hydrogen visibly escaping from the negative electrode, while, as will be seen from the table, there was no free acid formed in the negative compartment till two hours or more had elapsed. By that time some admixture in the horizontal part of the apparatus might reasonably be expected, and even in the greatest instance it is small as compared with the amount of salt decomposed.

Similar experiments were made with the sulphate of zinc, with similar results, no hydrogen being involved, and little or no sulphuric acid appearing in the negative compartment.

We conclude, therefore, that it is not possible to determine the composition, or even to show the presence of a hydrated salt in aqueous solution by means of this electrolytic method.

THE ANALYSIS OF SILICATES.

By W. KNOP.

THE author fuses 2 grms. of the finely pulverised sample with 10 grms. of sodium carbonate. When the crucible is perfectly cold, the melt, which detaches itself from the crucible all round, is placed in a capsule of at least 20 centimetres in capacity, and covered with 200 c.c. of water. The residues of the melt adhering to the capsule are dissolved in hot water and the solution is poured into the capsule, which is then allowed to stand for forty-eight hours at the common temperature. The melt swells up spontaneously and its solution is promoted by stirring every six or eight hours, so as to make the hard nucleus of the melt accessible afresh to the action of the water. After the melt is thus completely softened a quantity of sal-ammoniac, sufficient for its complete decomposition, is added, and the whole is evaporated to dryness at a temperature of 80° to 90°.

To find the needful quantity, 10 grms. sodium carbonate are dissolved in water coloured with litmus, and strong hydrochloric acid is added until the solution is reddened, for which 30 c.c. of acid are generally needed. Double the quantity, *i.e.* 60 c.c., of hydrochloric acid are then measured out, completely neutralised with ammonia, a slight excess of which is not injurious, and the solution thus obtained is added to the contents of the capsule.

The dried up matter is then covered with water, heated to a gentle boil for a quarter of an hour, and thus manganous chloride and phosphate of lime are brought into solution. They are filtered off, and there remains upon the filter a mixture of free silicic acid, insoluble in water and in acids, and of the undecomposed silicates of the sesquioxides.

From the filtrate the manganous oxide and phosphate are first separated. If the latter is present the solution passes clear through the filter only whilst it is concentrated. Subsequently, when it is diluted by the washing water, the manganous phosphate separates out in the filtrate as a milky turbidity, and thus the presence of traces of phosphoric acid in the mineral is made known. The residue on the filter is washed completely, without regarding the turbidity, until the water passing through shows no reaction of chlorine, and the filtrate is evaporated down to about 150 c.c. in a roomy capsule.

The liquid is then made slightly alkaline with ammonia and the manganese is precipitated by means of chlorine water. After standing from four to six hours on a water-bath at 50° to 60°, the manganese falls as a flocculent precipitate of hydrated manganese peroxide and manganic phosphate. Care must be taken to keep the liquid alkaline by the occasional addition of ammonia. If this is omitted a part of the precipitate re-dissolves. The precipitate is collected upon a filter large enough to receive subsequently the entire silicic acid, and lime and magnesia are then determined in the filtrate in the usual manner.

The silica and the sesquioxides remain upon the first filter. It is spread upon a glass plate, the contents are pushed with a glass rod into a capsule, the filter is washed into the capsule, pressed, dried, and burnt, and its ashes are also rinsed into a capsule. A sufficiency of hydrochloric acid is added, and the liquid is evaporated to dryness. The residue is treated with hydrochloric acid, and the silicic acid is filtered in the same filter upon which the manganese deposits were collected. The latter are re-dissolved by the acid liquid, and are washed away. On the filter there remains the silica in a state of purity, whilst alumina, iron, and manganese are separated in the filtrate.—*Zeitschrift Analyt. Chemie.*

THE UTILISATION OF THE RESIDUES OF PYRITES.

By M. J. CREUTZ.

IN 1874, M. P. W. Hofmann pointed out the occurrence of zinc in the burnt pyrites of chemical works, and proposed to make it available by means of a process which he described in the *Zeitschrift des Vereins Deutscher Ingenieure.* This process, which has been in operation for some years at the Wocklum Works, yields zinc chloride, which is sold at the average price of 10 francs per 100 kilos.

The treatment consists in lixiviating the burnt ore, and thus extracting the iron and copper sulphates; the lixivium,

concentrated to crystallisation, is mixed with a quantity of sodium chloride equivalent to the quantity of zinc sulphate dissolved, and deposits at first Glauber's salts, the value of which alone covers the whole expense of the treatment.

When the concentration reaches 50° B., various mixed ferrous and sodium sulphates separate out, and there remains in the mother-liquor merely zinc chloride, which is obtained by evaporating to dryness.

Notwithstanding the advantages which Hofmann's process offers at first sight, it has not been widely adopted. It must be observed, in fact, that the reactions do not take place as simply as it has been just described, and the separation of the salts is not sharply marked.

The sulphate of soda is not deposited entirely, and the liquors evaporated after crystallisation yield a dry mixture containing about 85 per cent zinc chloride and 15 per cent of sodium salts. The presence of these latter bodies, according to M. J. Creutz, is inconvenient in the application of zinc chloride to the preservation of wood.

According to an American patent (No. 236,051), claiming the reactions above mentioned, it is important to effect the mixture of sodium chloride with the solution of the sulphates at a low temperature. This indication may be previously found in *Dingler's Polytech. Journal*, vol. 153, p. 157.) In order to cool the liquids most suitably they are brought in contact with the refrigerating apparatus at their upper surface only. The process, thus modified, still does not give a zinc chloride sufficiently pure for the treatment of wood. Moreover, on melting a mixture of white vitriol and of salt, and dissolving the product in water, the first lixivium, at 48° B., always furnishes a dry product containing about 20 per cent of salts of sodium. It is also known that there exist several double salts of zinc and sodium, and it is hence not surprising that it should be found to separate sharply the salts of these two elements by crystallisation.

Hofmann has further studied a process patented in 1877 by Rivière de la Souchère: the double decomposition of iron and zinc sulphates by sodium or calcium chloride, and the precipitation of zinc oxide by lime. The results have been more favourable, and they have led to a method of treatment which is really practicable and advantageous. The burnt pyrites are exposed for some time to the air, in order that the compounds of iron and manganese and the sulphurous acid may be more completely oxidised. They are then systematically exhausted with cold water in a circulatory apparatus, which consists of three or four large tanks with false bottoms, arranged in stages; the liquid flows out at a plug-hole below, and passes through a lead pipe into the next tank below.

From burnt pyrites containing on an average 3 per cent of zinc, there is obtained a liquor marking about 20° B., and almost free from iron, with traces of manganese and cobalt. There is mixed with it a solution of calcium chloride at about 15° B. In a few moments there is produced a thin magma of calcium sulphate. It is well, when effecting this double decomposition, not to use calcium chloride in excess.

The filtrate marks about 10° B., and contains, along with zinc chloride, zinc and calcium sulphates and traces of manganese and cobalt. It is evaporated in pans heated by reverberation, because heat applied from below would occasion an incrustation of calcium sulphate. By adding a little chloride of lime to the boiling liquid the cobalt and manganese are precipitated. The last traces of calcium sulphate are deposited when the solution marks about 48° B.; it then contains merely zinc chloride and a little sulphate, and consequently corresponds in composition with the zinc chloride obtained by dissolving zinc in hydrochloric acid containing a little sulphuric acid.

The inconvenience of this process lies in the dilution of the zinc chloride obtained, which must be concentrated from 10° to 48° or 50° B. This is not the case with Hofmann's method, which, further, yields a saleable accessory product, the Glauber's salt. Still the calcium chloride process seems to have the advantage, as it alone yields a zinc chloride applicable to all purposes.

The author has sought to avoid the difficulty by lixiviating the burnt pyrites with a solution of calcium chloride. But, as might be expected, the extraction of the zinc remains in this case very incomplete; the calcium sulphate formed by double decomposition diminishes the porosity of the substance, and hinders the solution of the zinc sulphate. Calcium chloride, also, dissolves much iron and manganese, and nearly all the copper.

The production of zinc chloride by the process above described is most advantageous if we wish to prepare zinc hydroxide for desulphuring alkaline lyes. There is then no need to concentrate the liquors: they are simply treated with milk of lime, which throws down the hydroxide, whilst the lime dissolves as calcium chloride. After well stirring, the oxide is let settle, the solution run off, the deposit washed once by decantation, and the paste is spread on a sand-filter. The washing-water is absorbed by the sand, and the zinc oxide, in the state of a paste, is at once used for desulphurising caustic lyes.

In 1880, K. W. Jurisch proposed, instead of oxidising the red liquors by means of sodium nitrate, to desulphurise by means of zinc oxide. The zinc method yielded, according to his calculations, a saving of 14 to 15 francs per ton of caustic soda. But his zinc hydroxide was prepared by dissolving zinc in hydrochloric acid and precipitating with lime. Hence, if zinc hydroxide is obtained from burnt pyrites, taking labour and the cost of lime into account, there would be, as compared with the estimate of Jurisch, a further saving of 17 francs 65 centimes per 1000 kilos., or a total gain of 33 francs by the desulphurising process with zinc oxide.

This process might even be used for desulphurising the lixivium of black-ash. The zinc thus employed is lost, but its cost price in this case is so trifling that in many works it would be advantageous to extract the burnt pyrites.

The burnt ores being thus to a great extent freed from sulphur and zinc, which are troublesome impurities in its metallurgical treatment, would be sold doubtless for a better price than pyrites not treated.—*Revue Scientifique Quesneville.*

ON CARBONYL-DIPHENYL-OXIDE AND OXY-DIPHENYLEN-KETONE, TWO KETONES FORMED FROM SALICYLIC ACID, AND THEIR DERIVATIVES.

By R. RICHTER.

By the action of phosphorus oxychloride:—

I. Upon basic sodium or potassium salicylate or upon potassium salicylic ether, there is formed a ketone which may be regarded as carbonyl-diphenyl-oxide. This compound is converted by hydriodic acid and zinc powder into methylen-diphenyl-oxide, and this again with phosphorus chloride yields a bibasic ether-phosphoric acid.

Or, by fusion with potassic hydrate into carbonyl-dioxy-diphenyl, or into salicylic acid and phenol.

Or, by sodium amalgam into a compound—

$$\left\{\begin{matrix}(C_{12}H_8O)CO\\(C_{12}H_8O)CH_2\end{matrix}\right\}$$

Or, by the action of bromine, nitric and sulphuric acid into substitution derivatives.

II. By the action of phosphorus oxychloride upon neutral sodium salicylate or upon salicylic ether, there is formed an isomer of the above which may be regarded as oxy-diphenylen-ketone. It is decomposed:—

1. By ignited lime into diphenyl-ketone and diphenylen-oxide.
2. By zinc powder into diphenyl, and a body very readily soluble in alkali.

3. Its substitution-derivatives with bromine, nitric and sulphuric acid are more readily prepared than those of the isomeric ketone, and the nitration is attended by the elimination of an atom of carbon.

III. By the action of phosphorus oxychloride :—

a. Upon neutral potassium salicylate there is observed a different behaviour from that of the corresponding sodium salt ; the product contains phosphoric acid.

b. Upon neutral sodium meta-oxy-benzoate there is obtained an acid free from chlorine and phosphoric acid.

c. Upon neutral sodium para-oxy-benzoate there is obtained a neutral product containing chlorine.

IV. Phosphoric phenyl-ether yields carbonyl-diphenyl-oxide with the salts of all the three oxy-benzoic acids.

Other accompanying reactions occasion, *e.g.*, with sodium salicylate, the formation of the following bodies : ortho-phenyl-benzoic acid, diphenyl-oxide, and phenylen-oxide.—*Journal für Praktische Chemie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

IRON.

The atomic weight of iron has been determined almost exclusively from the composition of ferric oxide. Beyond this there are only a few comparatively unimportant experiments by Dumas relative to ferrous and ferric chlorides.

Most of the earlier data relative to the percentage of metal and oxygen in ferric oxide we may reject at once, as set aside by later investigations. Among this no longer valuable material there is a series of experiments by Berzelius, another by Döbereiner, and a third by Captaine. The work done by Stromeyer and by Wackenroder was probably good, but I am unable to find its details. The former found 30·15 per cent of oxygen in the oxide under consideration, while Wackenroder obtained figures ranging from a minimum of 30·01 to a maximum of 30·38 per cent.†

In 1844 Berzelius‡ published two determinations of the ratio in question. He oxidised iron by means of nitric acid, and weighed the oxide thus formed. He thus found that when O = 100 Fe = 350·27 and 350·369.

Hence the following percentages of Fe in Fe_2O_3.

70·018
70·022

Mean 70·020 ± 0·0013

About the same time Svanberg and Norlin‖ published two elaborate series of experiments ; one relating to the synthesis of ferric oxide, the other to its reduction. In the first set pure pianoforte wire was oxidised by nitric acid, and the amount of oxide thus formed was determined. The results were as follows :—

1·5257 grms. Fe	gave	2·1803	Fe_2O_3.	69·977 per cent Fe.
2·4051 ,,	,,	3·4390	,,	69·936 ,,
2·3212 ,,	,,	3·3194	,,	69·928 ,,
2·32175 ,,	,,	3·3183	,,	69·968 ,,
2·2772 ,,	,,	3·2550	,,	69·960 ,,
2·4782 ,,	,,	3·5418	,,	69·970 ,,
2·3582 ,,	,,	3·3720	,,	69·935 ,,

Mean 69·9534 ± 0·0050

In the second series ferric oxide was reduced by ignition in a current of hydrogen, yielding the subjoined percentages of metal :—

2·98353 grms. Fe_2O_3	gave	2·08915 Fe.	70·025 per cent.
2·41515 ,,	,,	1·6910 ,,	70·015 ,,
2·99175 ,,	,,	2·09455 ,,	70·014 ,,
3·5783 ,,	,,	2·505925 ,,	70·030 ,,
4·1922 ,,	,,	2·9375 ,,	70·072 ,,
3·1015 ,,	,,	2·17275 ,,	70·056 ,,
2·6886 ,,	,,	1·88305 ,,	70·036 ,,

Mean 70·0354 ± 0·0055

It is evident that one or both of these series must be vitiated by constant errors, and that these probably arise from impurities in the materials employed. Impurities in the wire taken for the oxidation series could hardly have been altogether avoided, and in the reduction series it is possible that weighable traces of hydrogen may have been retained by the iron. At all events it is probable that the errors of both series are in contrary directions, and, therefore, in some measure compensatory.

In 1844 there was also published an important paper by Erdmann and Marchand.* These chemists prepared ferric oxide by the ignition of pure ferrous oxalate, and submitted it to reduction in a stream of hydrogen. Two sets of results were obtained with two different samples of ferrous oxalate, prepared by two different methods. For present purposes, however, it is not necessary to discuss these sets separately. The percentages of iron in Fe_2O_3 come out as follows :—

70·013	A.
69·962	
69·979	
70 030	
69·977	
70·044	B.
70·015	
70·055	

Mean 70·0094 ± 0·0080

In 1850 Maumené's† results appeared. He dissolved pure iron wire in aqua regia, precipitated with ammonia, filtered off the precipitate, washed thoroughly, ignited, and weighed, after the usual methods of quantitative analysis. The percentages of Fe in Fe_2O_3 are given in the third column :—

1·482 grm. Fe	gave	2·117 grms.	Fe_2O_3.	70 005 per cent.
1·452 ,,	,,	2·074	,,	70·010 ,,
1·3585 ,,	,,	1·941	,,	69·990 ,,
1·420 ,,	,,	2·0285	,,	70·002 ,,
1·492 ,,	,,	2·1315	,,	69·998 ,,
1·554 ,,	,,	2·220	,,	70·000 ,,

Mean 70·0008 ± 0·0019

Two more results, obtained by Rivot,‡ through the reduction of ferric oxide in hydrogen, remain to be noticed. The percentages are :—

69·31
69·35

Mean 69·33 ± 0·013

We have thus before us six series of results, which we may now combine.

Berzelius	70·020	± 0·0013
Erdmann and Marchand	70·0094	0·0080
Svanbeg and Nordlin, Oxyd. ..	69·9534	0·0050
,, Reduc. ..	70·0354	0·0055
Maumené	70·0008	0·0019
Rivot	69·33	0·013
General mean	70·0075	0·0010

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† For additional details concerning these earlier papers I must refer to Oudeman's monograph, pp. 140, 141.

‡ *Ann. Chem. Pharm.* 50, 432. *Berz. Jahresb.*, 25, 43.

‖ *Berzelius's Jahresbericht*, 25, 42.

* *Journ. f. Prakt. Chem.*, 33, 1.

† *Compt. Rend.*, Oct. 17, 1850.

‡ *Ann. Chem. Pharm.*, 78, 214, 1851.

From this we get Fe = 55·891 ± 0·012; or, if O = 16, this becomes 56·0195.

Dumas's† results, obtained from the chlorides of iron are of so little weight that they might safely be omitted from our present discussion. For the sake of completeness, however, we will include them.

Pure ferrous chloride, ignited in a stream of hydrochloric acid gas, was dissolved in water and titrated with a silver solution in the usual way. 100 parts of silver are equivalent to the amounts of $FeCl_2$ given in the third column:—

3·677 grms.	$FeCl_2$ = 6·238 grms.	Ag. 58·945
3·924 „	6·675 „	58·787

Mean 58·866 ± 0·053

Ferric chloride, titrated in the same way, gave these results:—

1·179 grm.	Fe_2Cl_6 = 2·3475 grms.	Ag. 50·224
1·242 „	2·471 „	50·263

Mean 50·2435 ± 0·0132

These give us two additional values for Fe, as follows:—

From $FeCl_2$	Fe = 56·028 ± 0·119
„ Fe_2Cl_6	„ 56·189 0·062

Combining these with the value deduced from the composition of Fe_2O_3, Fe = 55·891 ± 0·012, we get this general mean, Fe = 55·913 ± 0·012. If O = 16, this becomes Fe = 56·042.

NOTES ON THE AMMONIA PROCESS FOR WATER ANALYSIS (ILLUSTRATED BY THE PUMP-WELL WATERS OF BROOKLYN AND NEW YORK CITIES).

By NELSON H. DARTON.

IT is with hesitation that I add to the now almost too voluminous literature of water analysis. The investigations of which I wish to give results have revealed, however, considerable matter of interest, especially in regard to the volatile nitrogenous matters which for some time have been known to be a constituent of polluted potable waters. Remsen, in his report on Boston water, in 1881, called attention to them more definitely, and Marsh quite recently has shown their influence on the results obtained in the analysis of even slightly contaminated waters.

The importance of recognition of these volatile constituents which are generally lost sight of in the ordinary method of analysis, as they pass over with the free ammonia but do not affect the Nessler reagent, is, however, as yet undetermined, and by investigations of its physiological action in the concentrated state upon rabbits I have been enabled to draw conclusions which I trust will not be without value in judging the character of a potable water, as the sequel will show.

It was also very desirable to investigate its association with the other ingredients generally present in contaminated waters; to what extent these relations change by allowing the waters to stand, and of the microscopic growths present in the waters examined; consequently the research was extended to include all these data as completely as the facilities in my laboratory would allow, and are given in the tables.

The waters selected for the investigations were known to be polluted with sewage and decomposing vegetable matter, and highly charged with these volatile nitrogenous matters of which I wished more particularly to investigate the characteristics. These were the well-waters of Brooklyn, more familiarly known as "pump waters." There are about three hundred of these wells and their pumps, most of them less than a hundred feet in depth, that yield a plentiful supply of cool, clear water even in the dry seasons. The sources of supply of these wells, or in other terms their water-sheds, are almost exclusively from water in filtering through the cobble-paved streets and backyards of houses, then through gravel and sand, finally collecting in impervious depressions, generally of clay, underlying the city. The area drained to each pump is quite extensive, as Brooklyn is built upon the slopes of numerous hills. So far as I can find, there was no system followed in locating the pumps; they are more abundant in the lower and older wards of the city, now populated by the poorer classes, and having with few exceptions the highest death rates of any portion.

The sources of pollution of these waters are numerous. The principal one is by infiltration—first through the filthy streets, covered with animal excreta and decomposing vegetable matter, then through the soil and subsoil, saturated with accumulated decayed and slowly putrefying matter, whose only source of elimination is by these waters—much of this finds its way to the sea, but no small proportion of it is raised in the pumps. Another source of pollution which I am led to believe is a very considerable one, is from the loosely built sewers and carelessly-joined drainage pipes from the houses. Then, again, from the loosely-floored stables, manure pits, corner cesspools, and closets in many of the backyards a great amount of sewage drains into the ground and adds to the pollution. There is naturally little or no opportunity for purification of these waters by aëration.

Three of the few remaining pumps in New York city were included in the investigation for comparison. These wells are similarly polluted to those of Brooklyn. Thirteen wells are indiscriminately selected, numbered in the table from Nos. 75 to 88, and including the three New York city wells.

The analyses were made at three intervals, first on the same day that they were drawn; second, after standing forty-eight hours, and third, after six days. During these intervals they were kept in bottles but half-filled and loosely stoppered.

The results were obtained as follows:—

Residue.—50 c.c. evaporated, dried for three hours at 100°, and weighed.

Loss on Ignition.—The above residue was ignited for twenty minutes, cooled, and weighed. Carbonic acid water was not added.

Chlorine.—Titration on 50 c.c.

Nitrites.—According to Preusse and Tiemann's description of the application of Griess's test (meta-diamidobenzol).

In these and other colorimetric examinations the colours obtained were compared with those produced in solutions of known strength of the constituent sought.

Nitrates.—By the zinc-copper-couple as described by Thorpe.

Oxygen Required.—By the moist combustion method of Wanklyn, half the quantities prescribed by him being taken.

Ammonia, free and albumenoid, by Wanklyn's method.—To obtain permanganate solution free from ammonia the following process was followed:—Freshly fused potassa was allowed to cool out of contact with the air in an exhausted bell glass; this and the proper amount of permanganate were dissolved in sufficient absolutely ammonia free water, readily obtained by re-distilling Ridgewood water with the proper precautions. The solution thus made was boiled in a distilling flask with a mark on its neck whereunto it held half a litre of water at 100° C.; it was connected with a condenser, and when 10 c.c. of distillate was found to be free from ammonia, the flask was filled with pure boiling-water and poured into thoroughly cleansed, small hot bottles of about 100 c.c. capacity, for which it was used. Frequent tests of this method re-

† *Ann. Chem. Pharm.*, 113, 26. 1860.

vealed not even a trace of ammonia, even when distilling from a half a litre and collecting the first 10 c.c. of distillate.

For measuring this solution a pipette of the form that I proposed before the Society some time ago* but with a three foot length of rubber tubing and two strong pinch-cocks. Upon it were two marks, one at 10 c.c. capacity, the other on the stem at 1 c.c.

In every instance 100 c.c. of the water was taken and the distillation conducted in 250 c.c. in distilling flasks of German glass.

Precautions were taken against the disturbing influence of ammonia in the air of the laboratory by placing dishes of dilute hydrochloric acid in the niche which was devoted exclusively to the water analyses. This did not, however, appear to be necessary.

In the estimation of the volatile nitrogenous matters 100 c.c. of the water were distilled, and every 10 c.c. of distillate diluted to 20 c.c. and then divided into two portions, one of which was Nesslerised directly and confirmed the free ammonia found in the first distillation, and the remaining portion placed in a 35 c.c. distilling flask joined to a miniature but effective condenser, some water and 1 c.c. of the permanganate mixture added and re-distilled—the 1st 10 c.c. of distillate always contained all the NH_3 and was Nesslerised, the difference between this and the first result being equivalent to the ammonia from the volatile nitrogenous matters. In order to determine some of its characteristics, if possible, all the waters examined were concentrated from 5 litres to 50 c.c. This we readily accomplished by distilling at first in half litres and collecting each first 100 c.c. distillate; these were mixed and the litre obtained distilled in two portions, each first 100 c.c. of distillate being likewise collected; to this a calculated amount of phosphoric acid was added to hold back the free ammonia, 50 c.c. was then distilled off and after re-distillation was found to be quite free from ammonia. After filtration through asbestos felting 1 c.c. distilled with sufficient permanganate mixture and the ammonia Nesslerised, showed that about two-thirds of the NH_3 of the volatile nitrogenous matter had been secured and all other bodies, both chemical and organised, had been left behind.

A number of fine young rabbits were selected and sufficient amounts of these concentrations were injected under their skin with the effects detailed after each table. This it was expected would confirm a suspicion that I had long entertained that these matters were deleterious to the animal economy, and is, I think, fully justified by the results obtained.

Microscopic examinations were made of the sediments from the waters which were generally very slight; and the various forms of life found, so far as I could identify them, are detailed after the tables. In order to separate and examine the Bacilli, Micrococci, and similar organisms, two methods of separation, or rather concentration, were tried, the first by adding osmic acid and allowing that which had been killed by its action to deposit; and the other by developing in a film of gelatin; both of these methods were found to yield quite satisfactory results, but preference was given to the latter on account of its larger yield. Before covering with the film a small amount of Cohn's developing liquor was added to the water. The dissolved gases were determined by the usual method of distillation and absorption by potash and pyrogallate of potassa. It may be well here to recall the significance of the relations of the proportions of the gases dissolved in water and their change upon standing. Water, under the most favourable conditions of purity and at 15° C., will dissolve 6·3 c.c. of oxygen and 11·7 c.c. of nitrogen, and the relation is only disturbed to any great extent by putrefaction of matter held in solution and also by the action of ferments.

At about the time that the research was commenced Dr. A. R. Leeds in a preliminary, and as yet unpublished, communication to the N. Y. Academy of Sciences, called attention to a new actinic method for determining putrescible organic matter in potable waters, which, in a number of trials he had found to yield extremely satisfactory results. Consequently it was thought desirable to include an investigation of the value of this new method.

The details of the process were orally communicated to me, and were quite closely followed. One hundred c.c. of the water is mixed with the same amount of decinormal silver solution, preferably the nitrate; the mixture in a closed bottle is exposed to light as long as it is acted upon, and the decomposition has been completed, the putrescible organic matter having been oxidised at the expense of the silver, which precipitates as metal. All is then poured through a Gooch filter, and this and the bottle washed with ammonia to dissolve haloid salts. The silver adhering to the inside of the bottle and that on the filter is then dissolved in nitric acid and determined as may be convenient; its weight in milligrammes multiplied by 10 equal parts per million, and by the ratio of 108: 16, equal oxygen required.

This process has so far yielded the most satisfactory results, and promises to be a convenient, applicable, and accurate method for the analysis of potable waters, if not alone, at least with the ammonia process, and when appreciable amounts of sulphides are absent.

The location of the wells and results of the physical and physiological examinations of the waters were as follows:—The effects on rabbits here spoken of are the effects produced by the subcutananeous injection of a small portion of the concentrated nitrogenous matter obtained as described.

No. 75. Corner of Johnson and Lawrence-streets.

Appearance in 2 ft. tube, bright and clear. Sediment slight. Microscopical examination of sediment:—Sand, fibrous, vegetable matter, a cyprus, diatoms, and a few yellow algæ.

The concentrated volatile nitrogenous matter injected under the skin of a rabbit caused violent diarrhœa, with vomiting and death in about an hour.

No. 76. Near corner of Myrtle-avenue and Lawrence-street.

Bright and clear. Sediment considerable, containing much sand, also, *confervæ*, *desmids*, *oscillatoræ*, *palmaceæ*, and *volvox*, two varieties of *amœba*, a *chilodon*, an *auginuillata*, *fluviataalis*, and numerous diatoms.

The effect of the concentrated nitrogenous matter on a rabbit was essentially the same as with No. 75, but more intense.

No. 77. Corner of Bridge and Tillary-streets.

Bright and clear. Sediment small, containing sand, fibrous vegetable matter, some diatoms, and a few dead *chætonotii*. Injection of the nitrogenous matter under the skin of a rabbit produced a slight transitory diarrhœa.

No. 78. Corner of Sumner-avenue and Bainbridge-street.

Strong odour of brewery swill, develops that of H_2S on standing. Sediment abundant, dark coloured, containing numerous algæ and animalculæ. The effect on a rabbit was to produce diarrhœa, cramps, vomiting, and death. A similar effect, though not so rapidly fatal, was produced on a cat.

No. 79. Corner Johnson and Bridge-streets.

Water clear and bright. Sediment small and containing scarcely anything worthy of mention. Effect on a rabbit similar to that of the previous one.

No. 80. Corner Chapel-place and Bridge-street.

140 feet deep. No sediment. Effect on a rabbit slight transitory diarrhœa.

No. 81. Near corner of Irving-place and Fulton-avenue.

Clear and bright. Sediment slight, consisting of sand, *diatoms*, *algæ*, several *cypri*, *chilodons*, and *amœbæ*. Effect on a rabbit, violent diarrhœa followed by slow recovery.

No. 82. Corner Bridge and Nassau-streets.

Water clear. Sediment large, containing sand, algæ,

* *Journ. Am. Chem. Soc.*, iii., 12.

and monads. The bacteria obtained by filming when injected under the skin of a rabbit caused diarrhœa and death. The same effect was produced by the concentrated nitrogenous matter.

No. 83. Corner Fulton-avenue and Carleton.

Water clear. Sediment inconsiderable. In this water the proportion of total ammonia was much less than the sum of the five and albumenoid together. It probably contained some substances oxidised by the permanganate to nitrates. The tests were duplicated with the same results.

No. 84. Corner Duffield and Johnson-streets.

Water clear. Sediment moderate, containing sand, numerous *diatoms*, *chilodons*, &c. Effect on a rabbit, violent diarrhœa, &c. Death in two days.

Some of this concentrated nitrogenous matter was also injected under my own skin. The effects were similar. Diarrhœa was produced in two hours, and continued for two days.

No. 85. Hanover-place near Fulton-street. Water clear. No perceptible sediment. Effect on a rabbit, intermittent diarrhœa lasting for about a week. The effect on my assistant was to produce a tendency to diarrhœa lasting four days.

No. 86. New York City, corner Thames and Church-streets.

Water clear. Slight odour of acetylene, which soon disappeared. Contained no volatile nitrogenous matter. Effects on a rabbit, nil.

No. 87. New York City, corner Dey and Greenwich-streets.

Water clear. Much sediment. Both the sediment and the volatile nitrogenous matter produced violent diarrhœa, and vomiting with rabbits, which in the case of the sediment terminated in death.

No. 88. Corner Church and Cedar-streets.

Similar to the last. Sediment contained vorticella and microstoma. The volatile nitrogenous matter injected under my own skin produced diarrhœa and vomiting from which I took a week to recover.

To determine whether the above results were exclusively due to the volatile nitrogenous matters and whether they existed in the water as such, or were formed during distillation, further experiments were tried from time to time during the research. That these volatile nitrogenous matters pre-existed in the waters was, I thought, very probable. To ascertain this the waters were, after being filtered through asbestos plugs (in all other respects they were as when drawn from the wells), injected in considerable quantity under the skins of rabbits. Symptons were produced very similar to those induced by the concentrated waters, and the distillates ftom the concentrated waters which had been found not to contain or develop the volatile nitrogenous matters. Well No. 86 greatly polluted, otherwise produced not the slightest discernible effect upon the animal's health, and when the free ammonia was allowed to accumulate in another portion and concentrated till it became two parts per million, on injection it produced exactly similar results.

In order to determine the effect of the less volatile portion of a water, some of that which had been filtered through the asbestos plugs of our other experiment, was distilled at a very low pressure at a temperature of about 84° C., as previous experiments had shown that all the readily volatile matters of this water were easily separated from it by heat, applied if for even a short time. That which remained and was injected in the rabbit produced little or no discernible effect. While in this and the first injectings, bacterial matter might have been implicated, the latter experiment would have failed on account of their sterilisation by the heat applied. Yet the volatile matters, in which in every instance I am sure there were no bacteria present, produced more or less violent diarrhœa, with the exception, I might again mention, of that from well No. 77, which, although when concentrated contained 7 parts per million, an amount equal to that in many of the others, produced no diarrhœa in the rabbit into which it had been injected. The only manner by which I can account for this is by assuming that the term "volatile nitrogenous matters" is a very elastic one, and includes both virulent and harmless amine compounds. Of the former, those of phenol, toluol, &c., and of the latter, ethyl, &c. This is a part of the subject, however, that I trust to be enabled to further elucidate, while it suffices in the present communication to show that the volatile nitrogenous matters accompanying the other pollutants in a sewage contaminated water probably are injurious to health, and that in an examination of a water to determine its potability, their presence and amount should not be lost sight of.—*Journal of the American Chemical Society*.

ON DETERMINING THE ROTATION OF LEFT-HANDED SOLUTIONS WITH THE GERMAN (*SCHEIBLER-VENTZKE-SOLEIL*) INSTRUMENT.

By GEO. S. EYSTER, Ph.D.

The following plan for determining negative rotation, in the absence of an instrument graduated for left-handed solutions, occurred to me some time ago. Though seeming quite obvious, I have not seen it in print.

If we use a + quartz plate reading n degrees to the right (either used instead of one of the cover-glasses, or sunk in an outside recess of one of the brass caps, and secured in place by a thin metal ring and three screws) in connection with a − solution of less rotating power the reading will be N or $n\text{-}x = \text{N} = -x = (\text{N-}n)$ where $-x =$ the rotating power of the solution in degrees of the instrument. For instance:—

The reading of the quartz plate is 90°.

The reading of the plate and solution is 66°, then $-x = 66° - 90 = -24°$.

Or in other words, the solution has lowered the reading from 90° to 66°; hence is left-handed and is equal in value to the difference between 90° and 66°.

It is best to use a plate reading from 80° to 100° rather than one of much less thickness, as apart from the facility it affords for using a double normal solution for inversion, the value and equality of that portion of the scale is better under control.

I have not had a good opportunity to test the method since it occurred to me, but its success, as one acquainted with the principle of the quartz compensator will readily see, is merely a matter of detail.—*Journal of the American Chemical Society*.

SECULAR INCREASE OF THE EARTH'S MASS

By ALEXANDER WINCHELL.

The thoughtful and suggestive researches of Ebelmen and T. Sterry Hunt, on the chemical and geological relations of the earth's atmosphere,* have led me to some further deductions, which seem to increase the interest in this field of inquiry. The general tendency of these studies is to show that the chemical transformations in progress upon the earth involve the fixation of a larger volume of atmospheric constituents than could probably have ever existed in the atmosphere at one time, and that they must consequently have arrived from interplanetary space.

1. *The Carbonates.*—It is generally agreed, as first shown by Hunt, that the carbonates of lime and magnesia

* See a memoir by T. Sterry Hunt in *American Journal of Science*, May, 1880, where references are given to numerous other publications.

have arisen chiefly through the interactions between carbon dioxide of the atmosphere, the decomposing silicates of the earth's crust, and the chloride of calcium of the ocean. The carbon dioxide has therefore been contributed by the atmosphere. To what does this contribution amount? We may assume, without material error, that the carbonates here in question are all calcium carbonate, with a specific gravity of 2·72. Then, the mean pressure of the atmosphere being about 14·7 pounds avoirdupois on a square inch, a little calculation shows that an amount of carbon dioxide in the atmosphere sufficient to double its pressure would yield only 8·627 metres of limestone. An amount sufficient to cause a pressure of 80 atmospheres would suffice for the formation of limestones equal to only a fortieth (0·02265) of the hundred thousand feet which, for this purpose, may be assumed as the thickness of the stratified rocks. But a pressure of 80 atmospheres at a temperature of 30° C. produces liquefaction of carbon dioxide. The actual proportion of limestones and dolomites in the earth's crust is about one-eighth, as I have shown by recent studies. This amount would yield, by the liberation of all its carbon dioxide, a pressure of 441·6 atmospheres. If we consider the limestones and dolomites formed since the period of the coal-measures, the proportion required to yield, on the liberation of its carbon dioxide, a pressure of 80 atmospheres, would be only 1-22nd (0·04469) of all the post-carboniferous strata. The actual proportion is about one-eighth, as for the whole stratified crust; and this would yield sufficient carbon dioxide to cause a pressure of 223·8 atmospheres.

It is not credible that such amounts of carbon dioxide have ever existed in the atmosphere at one time. During the larger part of the aeons of carbonate formation, animal life has existed in great abundance upon the earth; and this would have been impossible with 200 to 400 atmospheres of carbon dioxide present. As the proportion of this gas in the existing atmosphere is only 4½ parts in 10,000 by weight, 200 atmospheres of the gas would be 444,000 times the present proportion. It is scarcely more credible that the pressure of 200 to 400 atmospheres would have been compatible with either vegetable or animal organisation, so similar as it was fundamentally to modern organisation. As this large amount of carbon dioxide cannot be supposed derived from the earth's crust, it must have been derived from interplanetary space. This would imply an addition to the earth's mass of 0·0003806, which is about $\frac{1}{2628}$ part of the present mass

2. *The Kaolinisation of Felspars.*—Hunt has shown that the kaolinisation of a layer of 51·66 metres of orthoclase, or its equivalent of quartzo-felspathic rocks, would result in 23·7 metres of kaolin, and would use up 10,333 kilogrms. of carbon dioxide per square metre of surface. This is the weight of the atmosphere. Now, the whole amount of felspathic decomposition during the sedimentary ages must much exceed 500 metres in vertical thickness of kaolinic deposits. But 500 metres of kaolin represent 21·1 atmospheres of carbon dioxide; and, assuming the mass of the atmosphere at $\frac{1}{1\,200\,000}$ in relation to the earth, the carbon dioxide fixed in the processes of kaolinisation would be 0·0000175826 of the total mass of the earth.

3. *Decay of Hornblende, Pyroxene, and Olivine.*—According to Hunt, the decay of 10¾ metres of such minerals, or their equivalents in hornblendic and pyroxenic rocks, would yield carbon dioxide equal to 1 atmosphere: hence, if the earth's crystalline rocks have afforded 500 metres of hornblende and pyroxene, they must have fixed 48·387 atmospheres of carbon dioxide. This, in relation to the earth's mass, is 0·0000403209.

4. *Conversion of Ferrous into Ferric Oxide.*—As Ebelmen states, the conversion of 21,357 kilogrms. of ferrous oxide into 23,750 kilogrms. of ferric oxide would consume the whole of the 2376 kilogrms. of oxygen in the atmosphere (more exactly, 1·007 atmospheres) covering a square metre. If, then, we suppose the existence over the earth of 1000 metres of sediments derived from the decay of crystalline rocks containing only one per cent of ferrous oxide, weighing, according to Hunt, 25,000 kilogrms., this is 1·052 times the amount requisite to fix the oxygen in 1·007 atmospheres; that is, 10 metres of ferric oxide represent the fixation of 1·059 atmospheres of oxygen. This, in relation to the earth's mass, is 0·0000008825.

5. *Unoxidised Carbon.*—This occurs not only in coal-beds, but in pyroschists and petroleum. We find that the oxidation of a layer of carbon 0·7123 metre in thickness would use up all the oxygen in the atmosphere. A layer 2252 metres thick, and having a specific gravity of 1·25, if converted into carbon dioxide, would exert a pressure of 1 atmosphere. This would amount to 2,267,000 tons of 2240 pounds each on a square mile. Mr. J. L. Mott calculates that the amount of unoxidised carbon per square mile cannot be less, and is probably many times greater, than 3,000,000 tons. If we adopt this determination, it will imply a depth of 0·982 metre, and the proportion of the earth's mass will be 0·000000036318. This is the amount of carbon dioxide which must be decomposed to yield a layer of carbon over the earth only a trifle over three feet in thickness, while it is probable that the carbonaceous deposits of the earth's crust exceed this. Now, it will hardly be maintained that the uncombined carbon of the earth's crust was derived from any other source than the atmosphere, and mostly through the agency of vegetation. The earth's atmosphere must therefore have contained all this amount of carbon dioxide. With the fixation of the carbon, the freed oxygen, it may be said, might have been employed, as far as it would go, in the formation of ferric oxide, whose demands upon the atmosphere have just been computed; but as it would only satisfy $\frac{1}{3\,000}$ of those demands, it is hardly necessary to consider the question.

6. *Meteoric Contributions.*—If, as commonly assumed, 400,000,000 meteors enter our atmosphere daily, an average weight of 10 grains each would amount to a yearly addition of 93,170 tons. This, in 100,000,000 years, would amount to 0·000000001542 of the earth's mass, and would form a film 0·292, or nearly ⅜ of an inch thick, having a density of 2·5.*

Gathering together these various contributions to the earth's mass during 100,000,000 years, we have the following:—

1. CO_2 represented by the carbonates ..	0·0003806
2. CO_2 fixed in kaolinisation of felspars	0·0000175826
3. CO_2 fixed in decay of hornblendic and augitic rocks	0·0000403209
4. O fixed in conversion of ferrous oxide	0·0000008825
5. CO_2 represented by uncombined carbon..	0·000000036318
6. Meteoric contributions	0·000000001542
Aggregate	0·000439750722

This is an addition of $\frac{1}{2\,414}$ to the earth's mass; and, in the present state of knowledge, it does not appear on what grounds assent can be withheld from the result, or some result of similar purport. It must be left with the astronomer to determine what relation this increase may sustain to the moon's acceleration in its orbit and to other phenomena. It may be noted, however, that the remote secular recession and retardation of the moon, which G. H. Darwin has recently brought to view, would have been delayed by the cause here considered, and the time required for the attainment of the moon's present relations would have been prolonged, but to what extent remains to be determined.

The evidences disclosed by these recent researches, of the slow accession of gaseous and solid matters to the earth, possess a profound interest. It would almost seem that the earth's atmosphere is only so much of the intercosmical mixture of gases and vapours as the earth's mass is capable of condensing around it, and that the proportions of these gases are determined separately, each by its

* The value given for this film in a note, p. 14, in my "Worldlife," should be multiplied by 365¼.

own weight and elasticity and by its relative abundance in space; so that, as any one becomes diminished by fixation in the planetary crust, new supplies arrive to keep the ratio constant. As under this view it is apparent that an atmosphere should be accumulated around the moon, even after the saturation of the pores of its rocks, it may be said that the moon's mass and volume are such that her atmosphere would possess only $\frac{1}{36}$, or according to Neison, $\frac{1}{10}$, the density of the earth's atmosphere; and this degree of tenuity might reduce the lunar atmospheric refraction to the small value actually observed.—*Science*, Dec. 28, 1883.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, February 4th, 1884.

The Duke of Northumberland, LL.D., D.C.L., President, in the Chair.

The Earl Percy, M.P., The Lord Sudeley, The Rev. Edward Samuel Dewick, M.A., F.G.S., Mrs. Charles Hawksley, Sidney George Holland, LL.B., William S. Playfair, M.D., F.R.C.P., Augustine Robinson, James Thorne, and Robert Younger, B.A., were elected Members of the Royal Institution.

Sixteen candidates for Membership were proposed for election.

Sir Joseph Hooker, K.C.S.I., C.B., F.R.S., &c., was elected a Manager in the room of the late Sir William Siemens, F.R.S.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
January, 1884.

Force of Explosive Bodies according to Thermochemistry.—M. Berthelot.—A notice of a recent work in which the author has summarised a number of memoirs published in the *Comptes Rendus*, &c.

Treatment of Ores by Electrolysis.—M. Kiliani.—The author lays down general principles for electrolytic metallurgy. Ores must be distinguished as good and bad conductors; the former may serve directly as anodes, and are easily oxidised by the electro-negative radicles formed at their contact, and dissolve readily in the electrolyte. The bad conductors have to be placed in contact with a conducting anode, formed of an inoxidisable substance, such as platinum, manganese peroxide, or coke. In laboratory experiments a good conducting ore is electrolysed by suspension from a platinum wire in connection with the source of electricity, and is then immersed in the bath. On an industrial scale the ore, coarsely broken up, is placed in one of the compartments of a trough divided by a diaphragm. On the fragments of the ore which extend up outside of the electrolytic bath is laid a plate of copper connected with the positive wire. Care must be taken that this plate does not plunge into the bath, otherwise the current would not traverse the ore at all. The cathode is preferably formed of the same metal which is to be obtained. The bath should not contain organic acids. In practice the common mineral acids are employed, or their salts, selecting by preference a salt of the metal which is to be isolated. It is convenient to pass the current through the greatest possible number of small decomposition troughs, taking care that the resistance in each is not too great. With a current of one and the same intensity we obtain in n troughs n times as much metal as in a single one. To keep down the resistance of the circuit we employ poles of a large surface, *i.e.*, plenty of ore and baths which are as good conductors as possible. The state in which the metal is deposited at the negative pole depends on the secondary actions undergone by the electrolyte, and especially of the escape of gas. This is a function of the *density* of the current, *i.e.*, the proportion of its intensity to the surface of the cathode. If the density is too great there is an escape of hydrogen, and the metal is deposited in a spongy condition. If the density of the current falls below a certain minimum an oxide is deposited in place of metal. The electrolytic treatment of ores often renders it possible to separate the different metals which may be present. These are deposited in succession, and are sharply separated if the electromotive power is not too great. 1. Zinc.—The zinciferous compounds, calamine, blende, and zinc ash, are all poor conductors. They are first dissolved, and the salts obtained are electrolysed, employing anodes of coke. Blende should be roasted before it is dissolved. The electrolytic bath should be as concentrated as possible to avoid sponginess of the metal and an escape of hydrogen. In a saturated solution the formation of hydrogen decreases as the density of the current augments. 2. Lead.—Galena is a good conductor, and may be directly electrolysed. The best bath is a solution of lead nitrate. The arborescent crystallisations extend rapidly, and must be broken from time to time to prevent the formation of a metallic connection between the anode and the cathode. The sulphur of the galena falls to the bottom of the bath, and may be separated from the gangue by solution in carbon disulphide. 3. Copper.—Native copper sulphide, though a good conductor, cannot be directly electrolysed on account of the presence of iron sulphide, whence iron would be deposited along with the copper. The copper pyrites are roasted, dissolved in dilute sulphuric acid, and the liquid thus obtained is submitted to electrolysis.

The Electrolytic Separation of Zinc.—B. Kossmann.—With one horse-power, 8 kilos. of zinc are separated in twelve hours. Sometimes plates of brass are used as cathodes. The metal obtained contains a trace of iron. A number of poor calamines can be treated by this method which have been hitherto useless.

Utilisation of Burnt Pyrites.—J. Creutz.—See p. 62.

List of Patents.—A number of patent specifications, chiefly English and German, relating to metallurgy and chemical manufactures.

Industrial Conversion of Oleic Acid into Palmitic Acid.—W. Lant Carpenter.—From the *Journal of the Society of Chemical Industry.*

Extraction of Glycerin.—F. Bang recommends the use of distilled water, and in general of materials all previously purified.

Precipitation of Calcium Saccharate.—P. Degener.—The author has studied the influence of the alkaline and earthy-alkaline chlorides in the precipitation of calcium saccharate at a boil.

Alteration of Caoutchouc by Air.—C. A. Burghardt.—From the *Journal of the Society of Chemical Industry.*

The Injurious Influence of the Fumes of Metallurgical and Chemical Works upon Vegetation.—J. V. Schrœder and C. Reuss.—Insoluble metallic particles deposited on the leaves of trees are generally harmless. Soluble mineral matter, *e.g.*, arsenious acid, is hurtful only when in a concentrated state. Insoluble compounds of lead, copper, and zinc in the soil are not hurtful except

their proportion is exceptionally large. Soluble metallic compounds are injurious. One-tenth per cent of As renders a soil barren. The mineral acids do not act injuriously in the soil, but in the air they are destructive even in minimal proportions. Hydrochloric acid gas is less to be dreaded than sulphurous acid.

Influence of the Manufacture of Soda by the Ammonia Process upon the Value of Hydrochloric Acid and Chlorine.—Walter Weldon.—From the *Journal of the Soc. Chem. Industry*.

German Patents relating to Colouring-Matters.—A catalogue of specifications.

Lectures on Solid and Liquid Illuminating Agents, delivered before the Society of Arts.—L. Field.—From the *Journal of the Society of Arts*.

Review of Chemical Investigations published Abroad.—Abstracts of memoirs from the *Berichte der Deutsch. Chem. Gesellschaft*.

Introduction to the Study of Chemistry.—E. Grimaux.—An extract from a lecture delivered at the Ecole Polytechnique on the advantages of the atomic theory.

Constitution of Chloride of Lime.—L. T. O'Shea.—From the *Journal of the Chemical Society*.

Industrial Society of Mulhouse.—Meeting of the Chemical Section, November 14, 1883.—M. Bourcart read a paper on the direct method of indigo-printing invented by MM. Schlieper and Baum.

M. Noelting has undertaken a series of researches on the law of substitutions in the azo-compounds. He announced also that by means of bromine, aniline and toluidine may be very accurately determined in their salts, or in their aqueous or acid solutions.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Parts 18 and 19, 1883.

Carbonyl-diphenyl-oxide and Oxy-diphenylen-ketone, two Ketones formed from Salicylic Acid, and their Derivatives.—R. Richter.—See p. 63.

An Exhaustion-funnel heated with Steam and an Arrangement for cooling Surfaces for Sublimation.—R. Richter.—The arrangements in question cannot be intelligibly described without the accompanying illustration.

The Elementary Composition of Wheat-starch, and the Action of Dilute Acetic Acid upon Farina.—L. Schulze.—If starch is treated under pressure with acetic acid of a medium concentration for four hours, there is obtained a solution which gives with iodine a red colouration, and with alcohol a white precipitate. It reduces Fehling's solution only to a very slight extent, and possesses a somewhat considerable rotatory power. If purified it is found to be the dextrine α, described by Bondonneau. If the action of the acetic acid is prolonged the rotatory power of the product decreases, whilst its reductive power increases, the dextrine α being gradually converted into glucose.

Magnesium Bromide and Iodide.—Otto Lerch.—The author has obtained and described these compounds both in the anhydrous and the hydrated conditions; also the double bromides of magnesium and potassium, magnesium and ammonium, and the corresponding double iodides.

Chemico-critical Passages.—H. Kolbe.—A very sharp critique of the "Manual of Organic Chemistry," of Prof. Wislicenus.

A New Method of Preparing Phosphorus Oxychloride.—E. Dervin.—Potassium chlorate, dry and in fine powder, is added in small successive portions to phosphorus tri-chloride. The yield is 97 per cent of the theoretical quantity.

Alleged Transformation of Brucine into Strychnine.—M. Hanriot.—From *Comptes Rendus*, xcvii., p. 267, under which it has been noticed.

Justus Liebig's Annalen der Chemie,
Vol. 222, Part 1.

Communications from the Physical-Chemical Laboratory of the University of Leipzig.—These consist of a memoir by A. Hantzsch on the condensation-products of acetacetic ether; a paper by M. Pröpper on the action of fuming nitric acid upon acetacetic ether and its chlorine substitution-products, and remarks by A. Hantzsch on the last communication.

Substituted Benzoic Acids and the Nature of the Hydrogen Atoms in Benzol.—H. Hübner.—The first part of a voluminous dissertation, incapable of useful abridgment.

The Action of Sulphuryl-chloride upon Secondary Amine Bases.—R. Behrend.—The author describes tetra-methyl-sulphamide, dimethyl-amido-sulphuryl-chloride; its behaviour with dimethylamine; the action of gaseous hydrochloric acid upon tetra-methyl-sulphamide, dimethyl-diethyl-sulphamide, non-symmetrical dimethyl-sulphamide, dimethyl-phenyl-sulphamide, dimethyl-para-tolyl-sulphamide, dimethyl-sulphaminic acid, and its corresponding ether; diethyl-amido-sulphuryl-chloride, tetra-ethyl-sulphamide, and diethyl-dimethyl-sulphamide.

Bulletin de la Société Chimique de Paris.
No. 11 and 12, December 20, 1883.

Perfect Elasticity of Chemically Definite Solids. New Analogy between Solids, Liquids, and Gases.—W. Spring.—The author asks in the first place what is the cause of the different specific gravities of one and the same metal according as it has been cast, rolled, drawn into wire, or hammered? Does the difference observed prove a real condensation of the matter under the action of pressure, or is it merely due to the expulsion by pressure of gases which have been occluded when the ingot was cast? According to well-known researches metals such as platinum, gold, silver, and copper, which have been proved to occlude gases on fusion, and to let them escape, *incompletely*, on solidification, are precisely those which are most increased in their specific gravity by pressure. The author has submitted to pressures of about 20,000 atmospheres, metals which possess this property, either not at all, or to a very trifling extent, and he finds that though a first pressure produces a slight permanent increase of density, its repetition makes little difference. Their density is found to have reached a maximum. Hence the density of solids, like that of liquids, is only really modified by temperature. Pressure effects no permanent condensation of solid bodies, except they are capable of assuming an allotropic condition of greater density. The author's former researches tend to show that solid matter, in suitable conditions of temperature, takes the state corresponding to the volume which it is compelled to occupy. Hence there is an analogy between the allotropic states of certain solids and the different states of aggregation of matter. Possibly the different forms of matter may be due to a single cause, polymerisation. The limit of elasticity of a solid body is the critical moment when the matter begins to flow under the action of the pressure to which it is submitted, just as, *e.g.*, ice at or below 0°, may be liquefied by strong pressure. A brittle body is simply one which does not possess the property of flowing under the action of pressure.

The Action of Pressure on Solids in the State of Powder.—W. Spring.—A reply to the criticisms of MM. Friedel, Jannettaz, Neel, and Clermont (see *Bulletin de la Soc. Chimique*, vol. xxxix., p. 626, and vol. xl., p. 51).

Observations on the Experiments of M. W. Spring concerning the Action of Pressure on Solid Bodies in the State of Powder.—C. Friedel.—The author con-

siders that it may be effected by simple pressure, but doubts that it has really occurred hitherto.

MISCELLANEOUS.

The New Sibthorpian Professorship of Rural Economy.—Dr. Joseph Henry Gilbert, F.R.S., who has just been elected to the new Sibthorpian Professorship of Rural Economy at Oxford, in accordance with a scheme for its regulation sanctioned by the Chancery Division of the High Court of Justice, July 24th, 1883, studied chemistry at Giessen, under Baron Liebig, and took there the degree of Ph.D. Dr. Gilbert, who has long been a recognised leader in scientific agriculture, was elected a Fellow of the Royal Society in 1860, and served the office of President of the Chemical Society, and had the honour being elected a corresponding member of the Institute of France. The new professor will be required to lecture and give instruction on the scientific principles of agriculture and forestry. The electors were the Vice-Chancellor, the Sherardian Professor of Botany, the Professor of Geology, the Waynflete Professor of Chemistry, the President of the Royal Society, and the President of the Linnæan Society. The stipend of the new professor is £200 per annum, and the office is tenable for three years, for which period he may be re-elected on the termination of the time. The professor is required to give not less than twelve lectures in the course of the academical year in full term, but will not be allowed to give more than two in any one week.

Waterproof Paper and Pasteboard.—These articles are produced by treating the surface of ordinary paper with an ammoniacal solution of copper, so as partially to dissolve the surface, which is then let dry. Paper thus prepared is said to be equal in strength to parchment.—*Cosmos les Mondes.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Steatite.—Would you kindly inform me, through the medium of your journal, where I am likely to find a market for New Zealand steatite or soapstone, and its value per ton in England?—ENQUIRER.

MEETINGS FOR THE WEEK

MONDAY, Feb. 11th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Recent Improvements in Photo-Mechanical Printing Methods," by T. Bolas, F.C.S.
TUESDAY, 12th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8. (Anniversary.)
—— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
—— Society of Arts, 8. "The Portuguese Colonies of West Africa, by H. H. Johnston.
WEDNESDAY, 13th.—Society of Arts, 8. "New Process of Permanent Mural Painting, invented by Adolph Keim, of Munich," by Rev. J. A. Rivington.
—— Microscopical, 8. (Anniversary.)
THURSDAY, 14th.—Royal, 4.30.
—— Philosophical Club, 6.30
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
—— London Institution, 7.
FRIDAY, 15th.—Royal Institution, 8. "The Chemical Work of Wohler," by Prof. Thorp, at 9.
—— Society of Arts, 8. "State Monopoly of Railways in India, by J. M. Maclean.
—— Geological, 1. (Anniversary.)
SATURDAY, 16th.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.

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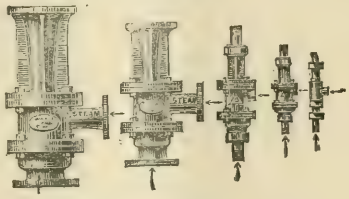

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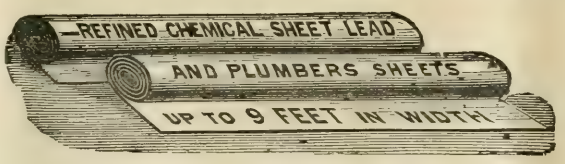

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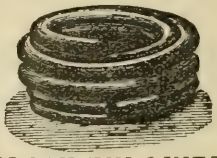

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Chapter I.—Construction of Microscope. Chapter II.—Mechanical Processes. Chapter III.—Mounting Objects Dry and in Balsam. Chapter IV.—Mounting Objects in Fluid. Chapter V.—Illuminating Apparatus. Chapter VI.—Polarised Light. Chapter VII.—Drawing and Micrometry. Appendix.

LONDON: E. J. DAVEY, Boy Court, Ludgate Hill, E.C.

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1264.

ON THE

CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.

By ALBERT R. LEEDS.

In the Chemical News, vol. xlviii., p. 199, will be found in full the article by Remsen and Keiser, to which I have alluded in my foregoing paper upon the "Conversion of Carbon Monoxide to Carbon Dioxide by Active Oxygen." Since both of these papers have appeared, a third, entitled "Contributions to a Knowledge of Active Oxygen," has been published in the *Berlin Berichte*, xvi., 2146, by Prof. Baumann, in which the results of repeating the experiments with carbon monoxide are given. The apparatus was constructed entirely of glass, and as the result of passing much larger volumes of purified air and carbon monoxide over moist phosphorus than I employed, correspondingly larger amounts of carbon dioxide were obtained. In one trial, after 700 c.c.m. CO, largely diluted with air, were passed through the activating chamber for fifteen hours, 36·6 m.grms. CO_2 were formed. In another experiment, 30 litres of air, containing 2·45 litres CO, yielded 64·6 m.grms. CO_2. In the latter case, 41 m.grms. CO, or 1·3 per cent of the entire amount of CO employed, had undergone oxidation.

AN IMPROVED FORM OF ORSAT'S APPARATUS FOR THE ESTIMATION OF OXYGEN.

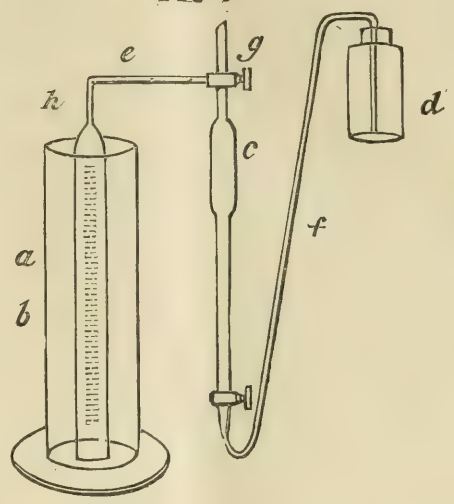
By J. B. C. KERSHAW.

The usual form of Orsat's apparatus used for the estimation of oxygen in mixed gases would be a very satisfactory piece of apparatus were it not for one grave defect, and that is, that the results are not accurate.

This inaccuracy is not owing to any defect in the absorbing solution, but arises from an error in the measurement of the gas. The form of apparatus generally used is shown in Fig. 1. The glass tube, *a*, contains the Cu gauze, and stands in the cylinder *b*, which contains the ammonium chloride solution. *a* is connected to the gas burette, *c*, by *e*. *d* is a bottle containing water, connected to *c* by the india-rubber tube, *f*.

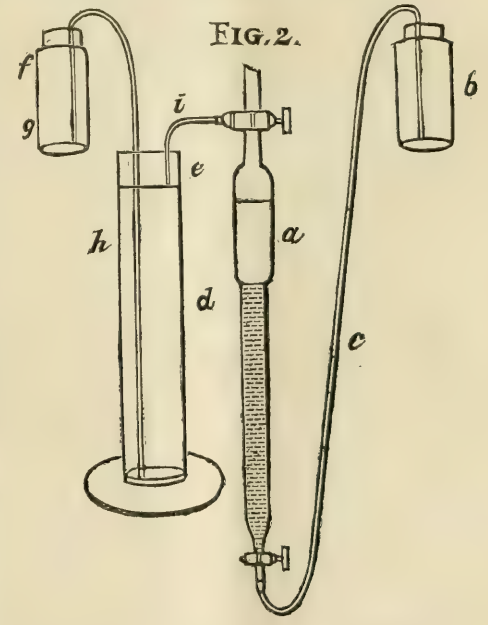
The method of working is as follows:—100 volumes of the gas to be tested are measured in *c*, and then the three-way cock, *g*, being turned so as to connect *c* with *a*, the bottle *d* is raised, and the gas forced over into *a*. As the Cu solution is forced out of *a* it rises in *b*, and on this account room must always be left in *b* for at least 100 c.c. more when the Cu solution is first put in. After remaining some minutes in *a* the gas is drawn back into *c*, and the loss is taken as the per cent of oxygen. Now the defect is this, that owing to the different levels of the Cu solution in *a* and outside *a*, the gas when measured the second time (after absorption) is at a greater tension than when first measured, and this causes an error of from 1 to 2 per cent in the results. The amount of error of course depends upon the difference in level between the solution in *b* and the fixed mark *h*,; the greater this difference the greater will be the the error, and *vice versa*. Anyone who uses this form of apparatus may satisfy themselves as to the existence of this error, by noticing the Cu solution drop from the mark, *h*, in *a*, when the stopcock, *g*, is turned so as to connect *a* and *c* (*c* being filled with gas measured at the normal pressure). The amount of error may be roughly determined by drawing the Cu solution up to the mark, *h*, and noticing the increase in volume; the increase was 2 c.c. with the apparatus with which I experimented, but it of course differs in every one. To overcome this defect it is evident that the Cu solution must be level with *h* in the outside cylinder, *b*, when *a* is filled up

FIG 1



to the same mark. Now, with this form of apparatus this is impossible, as some room (100 c.c. at least) must always be left in *b* to hold the solution forced out of *a* by the incoming gas.

FIG. 2.



The form of apparatus which I have devised to overcome this defect is shown in Fig. 2.

a is the gas burette connected to the bottle, *b*, containing the water for manipulating the gas by the india-rubber tube, *c*. *d* is a cylindrical glass jar about 12 inches long,

and 1¼ inches diameter, filled with a roll of Cu gauze, which should extend quite up to the cork, *e*. *f* is a bottle containing the NH_4Cl solution connected to the cylinder, *d*, by the tubes *g* and *h*. *d* is connected to *a* by means of a short piece of tube of very narrow bore, bent at right angles. The cork, *e*, must fit very tightly into *d*, and for this reason a cylinder with very thick sides must be chosen, as the pressure exerted by the cork is liable to break a thinner one. The method of working is as follows :—

The bottle, *f*, is fixed at such a level that the solution in *d* just rises to the fixed mark on *i*, when the stopcock, *j*, is turned so as to connect *d* with the air. 100 vols. of the gas to be tested are then measured in *a*, and forced over into *d* by means of the water in *b*; to accelerate the passage of the gas from *a* to *d*, *f* may be lowered so as to act as a syphon. After remaining in *d* a few minutes the gas is transferred back to *a*, by restoring *f* to its original position and lowering *b*. The loss will represent the per cent of O.

With this form of apparatus no error arising from difference of levels can possibly occur, as the solution in *f* can always be kept exactly level with the fixed mark on *i*, either by raising or lowering the bottle, *f*, or by adding to or taking from the solution in *f*. This apparatus is most convenient mounted on a retort stand. Two of the rings cut to the required size serve for supporting the burette, *a*, whilst the others covered with round pieces of wood will hold the cylinder, *d*, and the two bottles, *b* and *f*, in the required positions.

The slight error due to the absorption of the gas by the water used to manipulate it, may be obviated by covering the surface of the water in the burette with a thin layer of oil.

SPEED OF DISSOCIATION OF BRASS.*

By ROBERT B. WARDER.

The following determinations, which were suggested by Bobierre's† method for the separation of copper and zinc in alloys, were made by Mr. E. Twitchell.

A piece of brass wire, No. 17, 150 m.m. long and 1·43 m.m. in diameter, was heated to redness in a stream of hydrogen, in a porcelain tube, over a gas combustion furnace. The weight was taken from time to time, to determine the rate at which the zinc was volatilised. If the expulsion of zinc at each moment is proportional to the whole quantity of zinc then present in the alloy, we may assume—

$$\log.\frac{u_0}{u} = At.$$

where u is the weight of zinc present at the end of the time, t; u_0 is the initial value of u; and A is a constant, depending upon the temperature, surface, &c. To apply this criterion,‡ the values of 1000 A are given in the table. A direct determination gave 36·02 per cent of zinc in the brass used.

Time in Hours.	Weight of Alloy.	Loss per Hour.	Zinc present.	1000 A.
0	2·0570		0·7409	
1	1·9128	0·1442	0·5967	92
2	1·8527	0·0601	0·5366	70
3	1·7855	0·0672	0·4694	66
4	1·7418	0·0437	0·4257	60
5	1·7168	0·0250	0·4007	53
6	1·6957	0·0211	0·3796	48
9	1·6624	0·0111	0·3463	37
12	1·6339	0·0095	0·3178	31

The steady decrease in the last column shows that the formula used does not apply to the observations recorded, but that the rate of loss diminishes much more rapidly than the whole quantity of zinc present. This may also be seen by direct inspection of the third and fourth columns. Whatever relation may hold between the rate of loss and the quantity of zinc at the surface, we may suppose that the zinc in the body of the cylinder is transmitted toward the surface by a slow process of diffusion.*

Further experiments are proposed.

* Read before the Section of Chemistry and Physics of the Ohio Mechanics' Institute, May 31, 1883.

† *Comptes Rendus*, xxxvi., 224, 736 (1853). *Journ. f. Prakt. Chem.*, lviii., 380 (1853). "Fresenius's Quantitative Analysis," last American edition, p. 542.

‡ *Scientific Proceedings of the Ohio Mechanics' Institute*, i., 166-170.

COAL-GAS AS A LABOUR-SAVING AGENT IN MECHANICAL TRADES.†

By THOMAS FLETCHER, F.C.S.

Gas, as a fuel, is an absolute necessity to the economical carrying out of many commercial processes. It is often used in the crudest and most costly way; a burner may be perfect for one purpose, yet exceedingly wasteful for another, and however good it may be, an error of judgment in its application may lead to its total condemnation. An excess of chimney draught, in cases where a flue is necessary, may pull in sufficient excess of cold air to almost neutralise the whole power of the burner, unless a damper is used with judgment. With solid fuel, an excess of draught causes more fuel to be burnt, but with gas, the fuel is adjusted and limited; there is no margin or store of fuel ready to combine with the excess of air, which, therefore, lowers the amount of work done by its cooling power. The power of any burner, for any specified purpose, depends not only on its perfection, but to a far greater extent on the difference in the temperature of the flame, and of the object to be heated. For instance, if a bright red-heat is required, it is not possible to obtain this temperature economically with any burner working without an artificial blast of air, the difference between the temperature of the flame and that of the object heated is too little to enable the heat to be taken up freely or quickly, and the result is a large loss of costly fuel. If we want to obtain high temperatures economically, an artificial blast of air is necessary, and the heavier the pressure of air, the greater the economy. On the contrary, low temperatures and diffused heat are obtained best by flames without any artificial air supply.

For such purposes as ovens, disinfecting chambers, japanners' stoves, founders' core drying, and similar requirements, the best results are obtained by a number of separate jets of flame at the lowest part of the enclosed space, and the use of either illuminating or blue flames is a matter of no importance, as the total amount of heated air from either character of flame is the same. If there is any preference, it may be given to illuminating flames, as the proportion of radiant heat is greater, and this makes the average temperature of the enclosed space more equal; but, on the other hand, may be considered the greater liability of the very fine holes, necessary for illuminating flames, to be choked with dust and dirt. This may, to a great extent, be obviated by using very small union jets, and setting them horizontally, so as to make a flat horizontal sheet of flame. Burners placed this way are practically safe from the interference of falling dust or dirt, but not from splashes. Falling dirt or splashes must always be considered in the arrangement of any burners, and the ventilation must be no greater than is absolutely necessary for the required work. In cooking, this limit of ventilation may be exceeded, as most things are better cooked with a free ventilation, the extra cost of fuel being well compensated for by the better quality of the result.

The air in an oven or enclosed space heated by flames

* Colson has studied the diffusion of iron and carbon and some other solids; *Comptes Rendus*, xciii., 1074 and xciv., 26 (1882); abstracts in *Chem. Soc. Journ.*, xlii., 454, 357.

† A paper read before the Society of Arts, January 30, 1884.

inside is similar in character to highly superheated steam. It contains a large proportion of moisture, and yet has the power of drying any substance which is heated to near its own temperature. A mass of cold metal placed in the oven is instantly bedewed with moisture, which dries up as the temperature of the metal rises. This is, for many purposes, an objection, and the remedy is to close the bottom of the oven and place burners underneath. If for drying purposes, and a current of air is necessary, the simplest way is to place in the bottom of the oven a number of tubes hanging downwards in such a position that the heat of the flame acts both on the bottom of the oven and the sides of the tubes, which, of course, must be long enough for the lower opening to be well below the level of the flame. The exit may be at any level, but for drying purposes it is better at the top, and it should be controlled by a damper to prevent cooling by excessive currents of air. If not otherwise objectionable, the arrangement of flames inside the oven is far the most economical in use.

Where an oven or drying chamber is used continuously it should be jacketted with slag wool or boiler composition, but for many purposes this is no advantage. As an example both ways, I will instance the drying of founders' cores, where there is only one blow per day. The cores of an ordinary foundry can be dried by gas in a common sheet-iron oven in about half-an-hour; any accumulation of heat after that time would be useless, and a jacketted oven would be of no advantage.

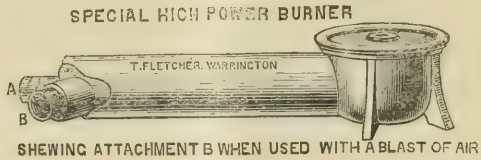
For the disinfection of clothes in vagrant wards and hospitals for infectious diseases, on the contrary, a continued heat is necessary, and in this case the accumulation of reserve heat, which takes place slowly in a jacketted oven, becomes of value, as the gas can be turned low or out, and the ventilators closed, ensuring a more complete disinfection with a much smaller gas consumption. Where an oven or heated chamber is much used for periods of over half-an-hour at once, a non-conducting casing pays well by reduced gas consumption.

For albumen and glue drying, leather enamelling, tobacco drying, and purposes where a large space has to be very slightly and equally warmed when the weather is unfavourable, steam-pipes are generally used, but, not being always available, an exceedingly good arrangement may be made by placing at intervals in the room gas burners, of any construction, close to the floor, and surrounded with a sheet-iron cylinder, say 2 ft. or 3 ft. high. The top of these cylinders must be connected throughout with a fairly large flue, which will take the products of combustion from the whole, and this flue must be carried either horizontally, or with a slight rise, so as to utilise all the waste heat. The reason for having a number of stoves at intervals is that the heat in a flue will not carry for any useful purpose more than about 8 ft. or 10 ft., and a single stove would give an irregular temperature in any except a very small room. If all are not used at once, the flues of those not in use may be closed by a damper to prevent down draught. The use of hot-water pipes heated by gas may also be occasionally advisable, but, unless for some special reason, it is much more economical to use coal or coke, as the bulk of water makes an exceeding good regulator, and makes a fire practically as steady and reliable as gas, thus superseding the more costly fuel.

For one of my own purposes I need hot-water pipes, having very little variation in temperature night and day, and using coke for economy's sake, I get a regular temperature by heating a large quantity of water, about 200 gals., with the fire, and enclosing this in a tank jacketted with slag wool. My circulating pipes run from this tank, and a practically steady temperature, night and day, can be obtained with the most irregular firing, and occasional extinction of the fire for several hours at once.

For the heating of liquids, the greatest economy is to be obtained from one single flame, of as high a temperature as can conveniently be obtained, and the flame must be in actual contact with the vessel to be heated. In jacketting vessels, to prevent draughts, care must be taken that the jackets do not cause currents of cold air to rise rapidly up the sides of the vessel, and so cool it. If this is the case, the use of a jacket, instead of being an economy, is a positive expense, and waste of heat. Many processes, such as making oil and turpentine varnishes, require a heat under instant control, and in these, the use of a gas is an important matter, as the loss and risk of fire are very serious elements of expense, more especially in small works where special and costly preparations for contingencies cannot be afforded. I have here a burner

Fig. 1.



which, for its power, is, perhaps, the most compact, and gives the highest temperature of any burner yet known, and it is easily made in almost any size; it has, I think, many special advantages. The use of gauze, which is its only weak point, is more than compensated for by the very high duties obtained in practice with it, owing to the compactness and concentration of the heat obtained. The following extract from my communication to the Gas Institute will give all particulars as to the constructive detail of this burner. Those who wish to go further into the matter will find the paper referred to in the publication of the Gas Institute for the current year, and also in the *Journal of Gas Lighting*, June 26th, 1883, and the *Review of Gas and Water Engineering*, June 16th, 1883.

"The first and most important part is the mixing chamber or tube, one end of which is supplied separately with gas and air, which at the other end are, or should be, delivered as a perfect mixture. It may be taken as a rule that this tube, if horizontal, should not be less in length than four-and-a-half times, or more than six times, its diameter. It is a common practice to diminish or make conical-shaped tubes. All my experience goes to prove that, excepting a very trifling allowance for friction, the area of the smallest part of the tube rules the power, the value of the mixing tube being no more than that of the smallest part. If the mixing-tube is upright new sources of interference come in; notably the varying specific gravity of the mixture. Except with one definite gas supply, the result is always more or less imperfect, and regular proportions cannot be obtained. This is now so well known that the upright form has been practically discarded for many years, and is now only used where the peculiar necessities of the case give some special advantage.

"The diameter of the mixing-tube is a matter of importance, as it rules the quantity of gas which can be satisfactorily burnt in any arrangement. With large flames, given a certain size of gas-jet, the diameter of the mixing-tube should be not less than ten times as great. For instance, at 1 inch pressure, a jet having a bore of 1-8th inch will pass about 20 cubic feet of gas per hour. To burn this quantity of gas, a mixing-tube is necessary, 10-8ths or 1¼ inch in diameter. By the first rule this tube must be in length equal to four-and-a-half times its diameter, or 5⅝ inches. It would appear that the mixing-tube, having 100 times the area of the gas-jet, is out of all proportion to the size necessary for obtaining a mixture of one of gas to nine or ten of air; but it must be remembered that the gas is supplied under pressure. It is therefore evident that no mere calculation of areas can be taken into account, unless the difference in pressure of the supply is also considered. A complete reversal of this law is shown in that ruling the construction of blowpipes, which I have already given in a previous paper on "The

Use and Construction of the Blowpipe." In these, the air supply, being under a heavier pressure, is much smaller in area than the gas inlet; and, to obtain maximum power, the air-jet requires to be enlarged in proportion to the gas pressure.

"Given a certain area of tube delivering a combustible mixture, the outlet for this mixture must be neither more nor less than the size of the tube. Taking an ordinary drilled tube, such as is commonly made, and of the dimensions before given—*i. e.*, 1¼ inch bore—if the holes are drilled ⅛ inch in diameter the tube will supply 10 × 10 = 100 of these holes. In practice this rule may be modified.

"The variations from the rule, however, must be a matter of experience with each form of burner. There is also the fact that with small divided flames it is not necessary to mix so large a proportion of air, as each flame will take up air, on its external surface; but in this case the flames are longer, hollow, and of lower temperature. As a matter of actual practice, where a burner is used which gives a number of flames or jets, the diameter of the mixing-tube does not need to exceed eight times the diameter of the gas jet; the remainder of the air required being taken up by the surfaces of the flames.

"Wire gauze, made of wire the thickness of 22 iron wire gauge, 20 wires to the linear inch, and tinned after weaving, has an area in the holes of 1-4th its surface. By calculation, the area of a gauze surface in a burner should, therefore, he taken at four times that of the tube, and our standard of 1¼ inch tubes requires a gauze surface of 2½ inches in diameter. This rule is subject to variation in burners of a small size, owing to the air that can, if required, be taken up by the external surface of the flame, which, of course, is much greater in proportion in a small flame than in a large one. Where the diameter of the gauze is, say, not over one or two inches, the theoretical maximum gas supply may be exceeded, and a varying compensation is necessary with each size. My rule is intended to supply to burners of larger diameters, where the external air supply plays a comparatively unimportant part.

"It must be remembered that burners of this class, which burn without the necessity of an external air supply in a flame which is solid, require the mixture to be correct in proportions. A very slight variation makes an imperfect flame. Not only does the gas-jet require to be adjusted with great precision, but it also needs more or less adjustment for different qualities of gas. An ordinary hollow or divided flame is able to take up on its surface any deficiency of air supply; but with the high-power solid flames the outside surface is small, and the consequence is that one of these burners, adjusted for gas of poor quality, may, when used with rich gas, give a long hollow or smoky flame, unless the gas-jet be reduced in size. When perfect, the flame shows a film of green on the surface of the gauze; and if a richer gas is used, the green film lifts away. To cause this to fall again, and to produce a solid flame, it is necessary to take out the gas-jet and tap the end with a hammer until, on trial, it is found correct. If too small, the green film lies so closely as to make the gauze red-hot. Where the 'tailing up' of the carbonic oxide flame is objectionable, there is no practical difficulty whatever in constructing these burners as a ring, with an air supply in the centre, which greatly reduces the length of the 'tail.' In practice it is a decided advantage to have a centre air-way in all burners of more than about 2-inch diameter, as it enables the injecting tube to be slightly shortened, and lessens the liability of the green film to lift with varying qualities of gas. In this class of burner I have adopted the small central air-way as a decided improvement in the burners."

(To be continued).

Iso-indol.—P. Friedlaender and J. Mähly.—The authors have obtained a compound which they regard as para-amido-α- or β-phenyl-amphi-nitril.—*Ber. d. Deutsch*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

COPPER.

The atomic weight of copper has been chiefly determined from the composition of the black oxide and the anhydrous sulphate. In dealing with the first named compound all experimenters have agreed in reducing it with a current of hydrogen, and weighing the metal thus set free.

The earliest experiments of any value were those of Berzelius,† whose results were as follows:—

		Per cent Cu in CuO.
7·68075 grms. CuO lost	1·55 grm. O.	79·820
9·6115 ,,	1·939 ,,	79·826

Mean 79·823 ± 0·002

Erdmann and Marchand,‡ who come next in chronological order, corrected their results for weighing in air. Their weighings, thus corrected, give us the subjoined percentages of metal in CuO:—

63·8962 grms. CuO gave	51·0391 Cu.	79·878	per cent.
65·1590 ,,	52·0363 ,,	79·860	,,
60·2878 ,,	48·1540 ,,	79·874	,,
46·2700 ,,	36·9449 ,,	79·846	,,

Mean 79·8645 ± 0·0038

Still later we find a few analyses by Millon and Commaille.‖ These chemists not only reduce the oxide by hydrogen, but they also weighed, in addition to the metallic copper, the water formed in the experiments. In three determinations the results were as follows:—

Grms.	Grms.	Grms.	Per cent.
6·7145 CuO gave	5·3565 Cu and	1·5325 H_2O.	79·775
3·3945 ,,	2·7085 ,,	0·7680 ,,	79·791
2·7880 ,,	2·2240 grms. Cu.		79·770

Mean 79·7787 ± 0·0043

For the third of these analyses the water estimation was not made, but for the other two it yielded results which, in the mean, would make the atomic weight of copper 63·087, ± 0·222. This figure has so high a probable error that we need not consider it further.

The results obtained by Dumas§ are wholly unavailable. Indeed, he does not even publish them in detail. He merely says that he reduced copper oxide, and also effected the synthesis of the subsulphide, but without getting figures which were wholly concordant. He puts Cu = 63·5.

Latest of all, and probably the best also, we have the determinations by Hampe.¶ First, he attempted to estimate the atomic weight of copper by the quantity of silver which the pure metal could precipitate from its solutions.

This attempt failed to give satisfactory results, and he fell back upon the old method of reducing the oxide. From 10 to 20 grms. of material were taken in each experiment, and the weights were reduced to a vacuum standard:—

20·3260 grms. CuO gave	16·2279 Cu.	79·838	per cent.
20·68851 ,,	16·51669 ,,	79·835	,,
10·10793 ,,	8·06926 ,,	79·831	,,

Mean 79·8347 ± 0·0013

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Poggend. Annal.*, 8, 177.

‡ *Journ. f. Prakt. Chem*, 31, 389. 1844.

‖ *Fresenius's Zeitschrift*, 2, 475. 1863,

§ *Ann. d. Chim. et Phys.*, (3), 55, 129.

¶ *Fresenius's Zeitschrift*, 13, 352.

Hampe also determined the quantity of copper in the anhydrous sulphate, $CuSO_4$. From 40 to 45 grms. of the salt were taken at a time, the metal was thrown down by electrolysis, and the weights were all corrected. I subjoin the results :—

40·40300 grms. $CuSO_4$ gave	16·04958 grms. Cu,	39·724
44·64280 ,,	17·73466 ,,	39·726
	Mean	39·725
		± 0 0007

We now have four series of experiments upon copper oxide, as follows :—

Berzelius..	79·823	± 0·0020
Erdmann and Marchand ..	79·8645	0·0038
Millon and Commaille.. ..	79·7787	0·0043
Hampe	79·8347	0·0013
General mean	79·830	0·0010

For copper we have—

From composition of CuO ..	Cu = 63·181	± 0·036
,, $CuSO_4$ (Hampe)	,, 63·171	0·012
General mean	,, 63·173	0·011

If O = 16, then Cu becomes = 63·318.

The close agreement between the two independent values for Cu is certainly very striking. It will be seen that Hampe's two estimates upon the sulphate carry (perhaps accidentally) much greater weight than all the experiments upon the oxide. This might seem like giving them undue credit, were it not for the fact of the remarkable concordance of the results above referred to. Either estimate for Cu would be valid without the other.

The following additional note has been communicated by the author :—

Since the foregoing chapter was published, Baubigny has printed some new data.* Two calcinations of pure $CuSO_4$ give, in mean, a residue of 49·810 per cent of CuO. Hence Cu = 63·306. If SO_3 = 80, this value becomes 63·394.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 7, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE PRESIDENT announced that a ballot for the election of Fellows would take place at the next meeting of the Society (February 21).

The following certificates were read for the first time :—F. W. Brown, J. E. London, G. A. Parkinson, G. Tunbridge, T. U. Walton.

The SECRETARY then read a paper, "*On the Expansion of Liquids*," by D. MENDELEJEFF, translated from the Russian by B. BRAUNER. Though every liquid has its own peculiar coefficient of expansion, a general expression for the expansion of all liquids has long been a desideratum. The generalisation now given by the author is founded on the additional experimental material collected by chemists chiefly for the purpose of studying the specific volumes of liquids at their boiling temperatures. In the present paper only the physical side of the question is discussed. Most of the data are derived from Thorpe's paper (*Chem. Soc. Journ. Trans.*, 1880, 141). The uniformity in the expansion of liquids shown by the examples given in numerous tables may be represented by the formula—

$$V = \left(1 + \frac{k}{n}\, t\right)^n$$

which is the same as that giving (according to Gay-Lussac's law) the expansion of gases. For gases $n = +1$; for liquids $n = -1$. The expression for liquids becomes, therefore,—

$$V = (1 - kt)^{-1} = \frac{1}{1 - kt},$$

and as the specific gravities are inversely proportional, if D = density at t, and Do the density at 0°, then—

$$D = Do(1 - kt).$$

The author then gives several examples of the close agreement obtained with the above formula, and the experimental results of Thorpe. Thus, with phosphorus tribromide, according to Thorpe :—

t =	40°	60°	80°	100°	120°	140°
V =	1·0348	1·0530	1·0720	1·0916	1·1123	1·1340
V calculated—	1·0348	1·0531	1·0721	1·0918	1·1123	1·1325

(k = 0·000841)

The author discusses the varying values of k, in the exceptional case of water at different temperatures. The results of the paper may be summed up as follows :—In the expansion of liquids a peculiar regularity and a qualitative uniformity is observed, and the equation given above may be taken as an approximation to reality, k being a constant coefficient characterising each liquid as the specific gravity, the boiling-point, &c. The author proposes to call k the determinator of expansion, and suggests that a determination of its value under different conditions is extremely important for the mechanics of liquids. The expression given above, although many liquids deviate slightly from it, is by itself sufficient in the majority of physico-chemical investigations just as Gay-Lussac's law is sufficient for most physico-chemical work with gases.

Dr. MORLEY said if the expression held with two liquids it ought to hold with mixtures. He examined some time back the expansion of hydrocarbon from petroleum, and found that k first increased, then decreased. Such a phenomenon could not be explained if the law was rigorously true.

Dr. ARMSTRONG read an extract from a letter of Dr. Thorpe, who had seen the paper, in which he expressed his satisfaction that the physical data which he had been at some trouble to obtain should have formed the basis of such an important paper.

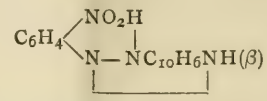
The PRESIDENT then called on Mr. R. MELDOLA to read a paper entitled "*Researches on Secondary and Tertiary Azo-Compounds, No. II.*" The author describes in this paper, in continuation of his former researches, the action of diazotised para-nitranilin upon tertiary monamines. In the case of dimethyl-anilin, the resulting product is para-nitro-benzen-azo-dimethyl-anilin,—

$$NO_2C_6H_4N_2C_6H_4NMe_2,$$

and this on reduction by ammonium sulphide furnishes the corresponding amido compound. The amido group in the latter is easily diazotised, and can be combined with phenols so as to form a new series of secondary azo-compounds. Para-amido-benzen-azo-dimethyl-anilin is a most delicate test for nitrous acid : when diazotised, and then neutralised with ammonia, a fine blue colour appears. By this test one part of sodium nitrite in 64,000 of water has been detected. The next portion of the paper deals with the action of diazotised meta-nitranilin upon primary, secondary, and tertiary monamines. The nitro-azo-compounds of the meta series could not be reduced by ammonium sulphide without complete decomposition, so that this method could not be applied for the preparation of secondary and tertiary azo-

* *Compt. Rend.*, 97, 906.

compounds as in the para series. The β-naphthylamine compounds, both of para- and meta-nitro-diazo-benzene, cannot be further diazotised by the action of nitrous acid, but furnish nitroso-derivatives. From this fact the author concludes that an amido group is no longer present in these compounds, and assigns to them the constitutional formula—



A comparison of the melting-points of the β-compounds both of the para and meta series also favours the view that they are differently constituted to the true nitro-azo-compounds derived from α-naphthylamin.

Dr. Armstrong thought the constitution suggested by the author highly probable. He had noticed with the naphthols the very marked difference between the α and β bodies.

Mr. Meldola, in answer to several questions, said that all the bodies were more or less coloured, but the more complex the body became the duller the colour seemed to be. There seemed to be a tendency to become bluer as the complexity increased. The difference between the α and β compounds seemed to depend on the fact that the most readily displaced hydrogen atom in the latter compound was the contiguous ortho-atom, so that we were really dealing with an ortho compound.

The Secretary then read a communication entitled, "*Note on the Nitrogenous Matters in Grass and Ensilage from Grass*," by E. Kinch. The object of the author was to determine whether, during the fermentations to which grass and other fodder crops are subjected in order to produce ensilage, the albumenoids undergo any change into other nitrogenous bodies not possessing the physiological functions of albumenoids; for, although the exact nutritive value of these non-albumenoid nitrogenous bodies is as yet unknown, it is certain that they can only replace the true albumenoids in food to a limited extent. The sample of grass was taken during the filling of the silo, on July 17, 1883. The grass was coarse, and contained notably thistles and *ranunculi*. It was passed through a chaff-cutting machine. The weight on the silo was about 50 lbs. per square foot. The ensilage was taken out on December 8; it was brown, scarcely acid, and had but little odour. It soon, however, developed a smell of acetic acid, which was subsequently replaced by that of butyric acid. It was readily eaten by cattle when mixed with dry fodder. The author gives detailed analyses of the grass and ensilage. The albumenoids were determined by the phenol, the copper hydrate, the mercuric hydrate, and the lead hydrate methods. The most striking change was in the relative quantities of the albumenoids and non-albumenoids. In the grass the non-albumenoids formed but 9 per cent of the total nitrogen; in the ensilage the non-albumenoids had increased to 55 per cent of the total nitrogen. So that during the fermentation in the silo nearly half the albumenoid nitrogen has been converted into non-albumenoid. Whether such changes in the nitrogenous matter always take place, or, as is likely, are diminished in extent by increasing the pressure to which the fodder is subjected, and what nitrogenous bodies are produced, are questions which the author hopes to answer in a future paper.

Prof. Church said that he had found it advantageous to add a little meta-phosphoric acid when employing his phenol process if the material was at all alkaline.

Mr. Vincent mentioned some experiments in which cows had been fed alternately on ordinary food and on ensilage. The weight of the cows remained constant, but when fed on ensilage the cows furnished on an average two gallons of milk more per diem. He also could confirm the fact that ensilage from clover has a most powerful odour of butyric acid.

Mr. Warington said that it was hardly possible to overrate the practical importance of ensilage. As far as he knew, Prof. Kinch had been the first to determine the relative quantities of albumenoid and non-albumenoid nitrogen in ensilage. There had been many analyses of grass and ensilage published, but no one yet had really made a quantitative experiment, *i.e.*, weighed all the grass which went in and the ensilage produced. We were also very much in want of analyses of foods as to the relative quantities of albumenoid and non-albumenoid nitrogen which they contained.

Mr. Friswell suggested that the experiment quoted as to the increase of quantity of the milk was of but little value unless the quality of the milk, as ascertained by analysis, was known.

Dr. Armstrong said it would have been interesting to know the quantity of nitrogen liberated by hypobromite.

Mr. Lloyd had endeavoured to investigate the form taken by the nitrogen, but had hitherto been unsuccessful. If too much pressure was used much nutritive juice was squeezed out of the grass. The great aim should be to avoid an acid fermentation.

The Secretary then read a paper "*On the Influence of the Temperature of Distillation on the Composition of Coal-gas*," by L. T. Wright. The author distilled a carefully mixed sample of Newcastle coal in a small iron retort. The charge was 2·24 lbs., and the distillation occupied twenty-five to forty-five minutes. Four experiments were made at various temperatures. With the lowest temperature 8250 cubic feet of gas per ton of coal were obtained, of 20·5 candle-power. At the highest temperature 12,006 cub. ft.; ill. p. 15·6. The gas in the first case contained 38·09 per cent H, 8·72 CO, 42·72 CH_4, 7·55 other hydrocarbons, and 2·92 per cent N. The gas obtained at the highest temperature contained 48·02 p. c. H, 13·96 CO, 30·7 CH_4, 4·51 hydrocarbons, and 2·81 per cent N. The author discusses the influence of marsh-gas, carbonic oxide, &c., on the illuminating power of the gas, and criticises the experiments of Frankland and Thorne. In the second part of the paper the author gives some analyses of gas drawn from retorts at different stages of the ordinary process of gas manufacture. The results confirm those obtained by Dr. Henry.

Prof. Foster said that apparently no analysis of the coal was given. He also gave an account of some experiments which he had made of passing steam over coke, and thus liberating the nitrogen contained in it.

The Society then adjourned to February 21, when a ballot for the election of Fellows will be held.

PHYSICAL SOCIETY.

Annual General Meeting, Saturday, February 9, 1884.

Prof. Clifton, President, in the Chair.

The motion to make Past Presidents permanent Vice-Presidents was carried, and the Articles of the Society altered accordingly.

Prof. Clifton read a Report on the business of the past year, which showed that steady work had been done by the Society.

Dr. Atkinson read the Balance Sheet, showing a flourishing condition of the Society.

A proposal to adopt certain letters to indicate Membership of the Society when placed behind the name was, on the motion of Prof. G. Forbes, supported by Professors Adams, McLeod, and others, held in abeyance for the present.

The Officers and Council for the ensuing year were then elected, and were as follows:—

President—Prof. F. Guthrie, F.R.S.

Vice-Presidents—Profs. R. B. Clifton, F.R.S.; W. E. Ayrton, F.R.S.; W. Chandler Roberts, F.R.S.; Dr. J. Hopkinson, F.R.S.; Lord Rayleigh, F.R.S.

Secretaries—Prof. A. W. Reinold, M.A.; Mr. W. Baily, M.A.

Treasurer—Dr. E. Atkinson.

Demonstrator—Prof. F. Guthrie, F.R.S.

Other Members of Council—Mr. Shellford Bidwell, M.A., LL.B.; Mr. C. W. Cooke; Prof. F. Fuller; Mr. R. T. Glazebrook, F.R.S.; Mr. R. J. Lecky, F.R.A.S.; Prof. H. McLeod, F.R.S.; Dr. Hugo Müller, F.R.S.; Prof. J. Perry; Prof. S. P. Thompson.

Honorary Member—Prof. H. A. Rowland.

Prof. CLIFTON then resigned the Chair to Prof. Guthrie, whose zeal for the Society he warmly praised.

Prof. GUTHRIE expressed his high appreciation of the courtesy and kindness of the retiring President while in the Chair.

Mr. W. LANT CARPENTER proposed a vote of thanks to the Lords of the Committee of Council on Education.

Mr. WHIPPLE moved the cordial thanks of the Meeting to Prof. Clifton.

Mr. GRIFFITH and Prof. ADAMS proposed a vote of thanks to the Secretaries, Demonstrator, and Treasurer.

Prof. G. C. FOSTER proposed a vote of thanks to the Auditors.

The Meeting was then resolved into an Ordinary one, and the SECRETARY read a paper by Dr. O. J. LODGE and J. W. CLARK, on the "*Phenomena Exhibited by Dusty Air in the Neighbourhood of Strongly-illuminated Bodies.*" In 1870, Dr. Tyndall described the dark or dust-free plane rising from a hot body in illuminated dusty air. The authors discuss his and other explanations of the phenomena, and give reasons against them. They have observed that the plan is only a prolongation of a dust-free coat or layer of greater or less thickness round the body. They have experimented with the coat in various ways detailed in the paper, but the general conclusion is that it is produced by (1) a molecular bombardment, (2) gravitative settling. It exists when the body is warmer than the air. The results are similar to those of Mr. Aitken, communicated to the Royal Society of Edinburgh.

Prof. FORBES observed that Aitken shows that a room heated by a stove will have dustier walls than one heated by a fire, owing to the air being hotter than the walls.

Prof. S. P. THOMPSON stated that he had found an electric discharge from a point in dusty air cause vortices in the air; that air shot off by the discharge sometimes eddying round again to the point.

NOTICES OF BOOKS.

A Centenary of Science in Manchester. For the Hundredth Year of the Literary and Philosophical Society of Manchester (1881). By R. ANGUS SMITH, Ph.D., LL.D., F.R.S., &c. London: Taylor and Francis. 1883.

WHATEVER may be the verdict that future generations will pass upon the doings of the human race of the nineteenth century—now in its last decade but one—the influence that experimental science applied to the arts has exercised on civilisation will form one of the most important factors that will have to be taken into consideration both by the politician and by the philosopher. However confident we may feel as to the immensity and variety of the wonders in Nature's storehouse yet to be brought to light by the efforts of future explorers, and of the illimitable cunning of the human intellect that may eclipse all our inventions and systems of philosophy and science, it must be admitted that the discoveries and advancements made during the present century are realities fit to be compared to the dreams of the ancient Orientalists, and such as would have petrified the sages of old Greece amidst their speculations.

The rise of the experimental method, which may be said to have taken place during the last hundred years, has given to society a new phase of intellect in the so-called scientific man, that phase of intellect characterised essentially as the sceptical, which requires to know the whys and the wherefores of phenomena, not resting satisfied with mere observation and conjecture. Our old seats of learning have until recently kept their doors closed against such men, under the belief partly that such studies had no humanising influence on character. There is probably a grain of truth in this supposition, for it may well be doubted if the study of dead matter does refine the sentiments or has any ennobling effect upon human nature, and whether the scientific man does not show traits in his character to be expected amongst some of the lower orders of untrained intellects.

As a retrospect of the science in Manchester for the last hundred years, to commemorate the centenary of the Literary and Philosophical Society in that city, Dr. Smith's work will be found to be of greater interest to the locality, and to those who have been and are connected with the Insitution, than to the scientific world at large. When, however, we consider that the history of the Society is intimately interwoven with the life-work of two men whose writings in its *Memoirs* have earned for the Society a world-wide renown, and that Manchester is now becoming one of the scientific centres of this country, it will be of some interest to give a short sketch of this Society, of which some of its members have played so important a part in the advancement of science.

To trace the ancestry of the Society it is necessary to take a glance at the town of Warrington, for here originated much of the spirit that was afterwards transplanted to Manchester and gave the Society its start. In the year 1757 an Academy was founded in Warrington for a small body of religionists, the projector of the institution being the Rev. John Seddon, and was established for "Protestant Dissenters." Several men of eminence took part in its classes, notable amongst whom was Joseph Priestley, who joined the Academy in 1761 as teacher of languages and *belles lettres*. Owing apparently to the pecuniary difficulties into which the Academy was drifting Priestley's connection with the Institution was broken off in 1767 by his removing to Leeds as minister of the congregation at Mill Hill Chapel. Although some effort was made to keep the Academy alive, yet the unbusinesslike habits of its trustees could not keep the establishment from sinking, and it was dissolved in 1783.

When the Academy at Warrington first opened its doors to the ardent youths of the district, the first name that was enrolled on the list was that of Thomas Percival, who ultimately became one of the founders of the Manchester Society. It was here that young Percival was first stimulated to the study of science, under the guidance of such men as Priestley and Dr. Aikin, and acquired that enthusiasm for natural phenomena which he afterwards carried with him to Manchester. After a complete medical education, beginning at Edinburgh, passing to London, and then to Leyden, Dr. Percival took up his residence in Manchester to follow out his profession. Dr. Percival did not, however, allow his professional engagements to engross all his time; with his high social position and scientific tastes he soon attracted all the talent of the town around him, and the outcome of the pleasant social gatherings at his house was the foundation of the Manchester Literary and Philosophical Society, the first formal meeting taking place in 1781. There are many Societies which can trace their origin to such small beginnings as those of which Manchester may boast; indeed those Societies which have existed for any time have as a rule arisen from private social gatherings of men meeting to exchange ideas as a form of relaxation from the weightier matters of daily life.

Evidently the moving spirit at this time with regard to scientific matters in Manchester was Dr. Percival. He had already won some distinction by his early writings on sanitary subjects. His first attempts at sanitary reform date as far back as 1773, about which time he put forth his "Proposals for Establishing more Accurate and Com-

prehensive Bills of Mortality in Manchester," advocating the establishment of a register of births and burials in every town and parish, which he considered "would be attended with the most important advantages, medical, political, and moral."

The important action taken by Dr. Percival and his friends was the establishment of a committee for superintending the health of the poor in Manchester and Salford. From Dr. Percival's remarks in 1796 the contemplated objects of the Board of Health were—

1. To obviate the generation of diseases.
2. To prevent the spreading of them by contagion.
3. To shorten the duration of existing diseases, and to mitigate their evils, by affording the necessary aids and comforts to those who labour under them.

The thoughts that were then spoken, and the plans proposed for lessening the evils that arise as regards sanitary matters when masses of human beings congregate together, the greater part of whose existence consists of a struggle for the bare necessaries of life, were the same as those of the present generation, and yet the evils and consequent misery remain. So much, indeed, were sanitary matters discussed at this period that Manchester became the great centre of sanitary "reform," and Dr. Percival its true apostle.

With respect to this subject it is interesting to learn that as early as 1852 the use of carbolic acid as a disinfectant was well known in Manchester, and the manufacture of such powders carried on by Mr. Alex. McDougall.

It was not till 1785 that the first volume of the Society's *Memoirs* was published, or four years after the first meeting had taken place, namely in 1781. At this first meeting the Presidents were Peter Mainwaring, M.D., and James Massey, Esq. Dr. Percival's relation with the Society at this point seems rather vague, for the author tells us that "he (Dr. Percival) was not in an active condition at the time, and did not attend the first seven meetings, and was not first President," whereas in the list of "present" at the second meeting we notice Dr. Percival's name; also in the first list of members published by the Society, Massey and Percival are Presidents.

In the "Memorials of St. Ann's Church by the Rev. C. W. Bradsley, M.A.," the foundation of the Society is claimed for the Rev. Samuel Hall, a Minister and Curate of St. Ann's. This clergyman by his activity may have helped to make the movement a decisive one, but there seems to be no reason for altering the account of the ruling spirit in the matter.

Some of the extracts from the earlier papers read before the Society, with which Dr. Smith has interspersed his history, appear somewhat amusing to the present generation, being clothed in the then accepted theories in science; and reading them one cannot help wondering in what light our now present hypotheses regarding atoms and molecules, bonds, valence, and constitutional formulæ will appear to the readers of science a hundred years hence. In an address by Thomas Henry, F.R.S., "On the Advantages of Literature and Philosophy in general, &c.," read in 1781, he says—"Bleaching is a chemical operation. The end of it is to abstract the oily and phlogistic parts from the yarn or cloth, whereby it is rendered more fit for acquiring a greater degree of whiteness and absorbing the particles of any colouring materials to which it may be exposed." And again—"The ingenious Dr. Priestley has even taught us the art of fabricating it (common air) artificially, of producing it in a degree of purity far exceeding that of the most salubrious climate, and of reducing it to the state in which we commonly breathe it when debased by exhalations from the various bodies which it surrounds. This excellent philosopher.... has also first discovered....the method by which Nature makes use of the leaves of vegetables to purify the atmosphere, when contaminated with putrid or phlogistic vapours."

One prominent figure in the Society at the beginning of this century was Dr. William Harvey, F.R.S., whose work on the absorption of gases by water has come down to us. Born in 1774, he became assistant to Dr. Percival, went to Edinburgh for his medical degree, in which town he studied chemistry under Dr. Black, his enthusiasm for science being raised to the highest degree. The facility he had acquired in manipulating with gases was considerable, and was turned to good account. By the electric spark he decomposed muriatic acid over mercury and obtained calomel and hydrogen, the result of which experiment, however, was not interpreted by him. By his experiments in 1803 on the absorption of gases by water he supported the theory of Dalton that the effect was due to mechanical agency. He also applied spongy platinum for effecting the combination of hydrogen with oxygen.

In a kind of prelude to a short biographical notice of Charles White, F.R.S., the author of a volume entitled "An Account of the Regular Gradation in Man and in Different Animals and Vegetables, &c., from the former to the latter," one of the original four Vice-Presidents of the Society, Dr. Smith employs some hard phrases with regard to the supporters of those theories bearing upon the variations observed in organised matter that have been most energetically brought forward during the last twenty-five years. The Manchester Society has already two names on its scroll of which it may well be proud, of men who have mightily influenced the study of material phenomena, and we see no reason, therefore, why it should not have had its pre-Darwin. "Few people would expect the doctrine of progress in creation to have any representatives in the early Manchester Society, but this is chiefly because it seems so little known how far the world had advanced in the idea, and how many persons allowed it to pass through their minds."

What is true of this theory is only too true of all others that have played any important part in knowledge,—the great difficulty in assigning the due amount of credit to each individual thinker. No great theory ever sprung into existence at once: there has been a slow progress of development in these things as in the progress of organised matter, and the unconscious influence that previous notions or previous varieties bear upon the present cannot very well be traced.

We are told that "Gradation in animals Dr. White saw clearly, but he refused to believe in development from species to species," but in view of the many writers previous to the time of White, through whose minds the same ideas of "progress" had hovered and passed in a dim and vague form, we experience difficulty in determining what and how much credit is to be given to Dr. White for his views with respect to this doctrine. Dr. Smith states that "there is a kind of insanity spreading among scientific specialists, strongly developed among Darwinians so-called, but the larger mind of Darwin never sanctioned it. They speak of natural selection as a power, when it is only a method by which a power operates. In the same way differentiation is treated as a power, and people actually think they explain when they tell us of this occurrence in nature. This, instead of stength, is the utmost weakness. Darwin has not shown this, but the weaklings (and nearly all his followers have been slow to reason) will now probably think that geotropism and apogeotropism will take the place of nature's most occult laws, and will fancy these words also to be explanations." These are sweeping statements to make, and we can do no more than quote them here. The meanings to be attached to the words "power" and "method" as used in these statements are to us vague: the phenomena mentioned, however, appear to us as the attributes of organised matter, and show its wonderful plasticity in responding to external conditions. We grant that some enthusiasts may have overstepped the bounds of reason, and in consequence we may have a surfeit or "organic progression" as well as of atoms and molecules. A theory that is shown to explain, to the satisfaction of many, various phenomena, may be pushed too far, and produce a reaction. Dr. Smith evidently admires some

of the arguments that have been brought forward with regard to the great law of progression in creation, and states that "some people also think that the 'survival of the fittest' is a great discovery," and asks "what else could survive?" "Were there ever men who believed that the least fit to live could live longest? It is, however, a telling expression—a name for a fact." Is this fact, then, self-evident, and does Dr. Smith see among the races of human beings in their present states of civilisation the "fittest" alone surviving? If so, the term "fittest" requires a clear definition, and he must grant that nature takes as much if not more care in preserving, refining, or developing what we are accustomed to look upon as the morally bad sentiments as those on the other hand which are considered to form the beautiful, the pure, the unselfish side of one's character.

The central figure in Dr. Smith's book is John Dalton, a man, to use the words of Dr. Smith, when he arrived amongst the members of the Society, whose "education was meagre; he could not make Latin quotations with Dr. Percival, or search into early classic writings with Dr. Falconer; his knowledge of Greek was but slight and gained from a little-used 'Schrevelius'; his manners were not formed amongst men who attended the Court; he kept no private carriage, and invited no one to dine with him. He did not even read much poetry, and he thought little in the region of metaphysics, . . . , but the whole force of his mind was directed to the explanation of natural phenomena."

It must have been a memorable day in Dalton's career when he arrived in Manchester in 1793 as Professor in the Academy. He did not come empty-handed, for his "Meteorological Observations and Essays," which he had worked on during the previous five years, he brought with him ready for publication. As a professed mathematician he entered the Society, but his mind soon took its natural bent—the study of phenomena.

Dalton's first publication in the *Society's Memoirs* was entitled, on "Extraordinary Facts relating to Vision of Colours," in which the anomaly now known as "colour-blindness" was described. It would seem, however, that the attention of the Society had already been drawn to this fact before Dalton's time, for Dr. Smith tells us that "the discovery of colour blindness has hitherto been given to Dalton, and unquestionably he first raised it into the region of science; but it has not been observed so far as the writer knows, that Mr. Bew or anyone else had observed the peculiarity."

The great work of Dalton, the "Doctrine of Chemical Atoms," is dealt with at considerable length by Dr. Smith, and the claims that have been made for Wenzel and Richter are discussed, as well as the history of the atomic theory amongst the early Greek philosophers. Much of this account has been taken from a former work by the author, now out of print; nevertheless it is advisable to reproduce it here in support of Dalton's claims.

It would seem, from Dr. Smith's account, that Wenzel's claims as the discoverer of reciprocal decomposition, have been going through the world greatly as a matter of hear-say, as from the difficulty the author experienced in obtaining a copy of Wenzel's work, few persons read it, or accurately knew its contents. Dr. Smith, however, has read the work carefully, and it may be well to give a few quotations of his opinion:—"To Wenzel has often been given the honour of discovering reciprocal proportion, but we must conclude that he failed in his attempts to explain the mutual decomposition of salts, and considers that it is not complete. . . . . I found no such passages as are imputed to him. . . . . It is a curious fact that not only does he not see this [reciprocal saturation], but he sees and explains the contrary, as he shows us that in double decomposition something always remains unsaturated, but generally very little remains."

We are inclined to consider Dr. Smith's opinion in this matter an impartial one, unbiassed by any feeling to attempt to claim more honour for Dalton than is his due; still we cannot but think that Dr. Smith is somewhat rash in his statements regarding some of Wenzel's ideas. To quote again:—"He [Wenzel] seeks to explain affinity by the time of action, and says: 'The affinity of bodies with a common solvent is in the inverse ratio of the time taken to dissolve.' To attempt to give the numerical or dynamical ratio of every body to each other was an object of the very highest kind, and we must look on him as one of those less fortunate men, who, when search was required in every direction, has had the wrong one assigned to him. He searched in the direction of time, and obtained a manifest fallacy; as bodies are constructed abstractedly he might be correct, but his theory cannot be introduced into science at present, and in the way he introduced it it is entirely a mistake."

Now, one thing seems certain, and that is that the method by which chemical affinity is to be measured is not clear; indeed, the very term itself is ambiguous. We know, for instance, that bodies may be cooled to such a temperature that no chemical action is perceptible, no affinity is manifested between them, or they may be heated so highly that the same appears true, whilst at intermediate temperatures action takes place, and probably at some fixed temperature the rate at which this action takes place, the manifestation of the affinities between the bodies, exhibits itself most. Wenzel's axiom may not be quite correct, still the idea of time must be and has been in recent years introduced into investigations on chemical affinity; and the rate at which chemical reactions progress, or the energy with which affinity shows itself, how physical causes and foreign substances influence the rate, will most assuredly form one of the grand keys to the comprehension of the mysterious action we call chemical, which has hitherto been so sadly neglected, and its study may even lead to a more rational classification of chemical compounds on a dynamical basis.

Dalton's theory has now been before the world for three-quarters of a century, and it has certainly not been neglected. By its aid the facts of chemistry have been raised from a chaotic heap to one of order. No matter how amply it explains the numerical relations as regards the masses or weights of chemical compounds, one cannot be blind to the great difficulties in viewing phenomena, as being produced by indefinitely small monads, such monads for instance as we are treated to in the kinetic theory of gases, flying through space, whirling and dancing to the eternal clatter of their own encounters. To conceive, for instance, a mixture of two such monads as hydrogen and oxygen, and observe the effect of heat upon them or the passage of an electric spark, it is difficult to comprehend how the "union" can take place. Their agitation must be great before they join hands, by their ceaseless collisions; but we must agitate them a little more, and see the result, or agitate them still more strongly, and again see the new result in their splitting asunder. So, again, in such a case as the passing of chlorine over phosphorus: three monads or five monads of the chlorine attach themselves to one of the phosphorus; but what about the intermediate stages from the one to the five which must take place in course? We may assume hooks, or claws, or bonds, nuclei with ether spheres, vortices, and what not, repulsions, or attractions as the inverse fifth or other power of the distance to bring theory and fact into harmony; but these assumptions seem to us only to indicate the great difficulty universally felt of co-ordinating the theory of monads with the phenomena of matter. A deep study of what we call chemical action is required, not constitutional formulæ or equations, to form a new theory of the constitution of matter.

That period of the Society's growth which is considered as the intermediate would seem to be essentially an engineering one, and is marked by some well-known names. A notable figure during this period is that of Sir William Fairbairn, Bart., F.R.S., whose mechanical ability has earned for him a high position in the annals of engineering. His career might be well worth a close

study, as his success lay not in an elaborate scientific education or an expertness with the symbols of the mathematician, but resulted more from instinctive feeling of what ought to be.

Another eminent engineer who adorned the Manchester Society was Mr. Eaton Hodgkinson, F.R.S., by whose assistance, with a high scientific training and knowledge of the strength of materials, no small part of Fairbairn's engineering works were rendered successful, including the stupendous undertaking over the Menai Strait.

A most remarkable man, a member of the Society, was the electrician, William Sturgeon, whose discoveries and inventions in electricity may be traced under modified forms in many of the principal electrical apparatus now in use, but whose claims to honour are well nigh if not quite ignored. He was born in 1783, and from first to last his life was one of labour and poverty, yet it is marvellous how much excellent work he performed in the trying circumstances. Beginning life as a private soldier, in spite of all the difficulties inherent in such an existence, by great industry he acquired considerable proficiency in science, not neglecting either the literary side of education. His contributions to science, commencing in 1823, are about fifty in all, published in the *Philosophical Magazine* and the "Annals of Electricity," all bearing on his favourite study, electrical phenomena. To Sturgeon we are indebted for the soft iron electro-magnet, the commutator, and the amalgamation of the zinc plates of batteries and numerous electrical investigations, but we must refer to Dr. Smith's book for a full account of his work. Sturgeon's claims have been sifted to the utmost, and firmly established by Dr. Joule, whose account of the life of this remarkable man is to be found in the *Society's Memoirs*, vol. xiv., 2nd Series.

One of the last scientific notables in Dr. Smith's volume is Dr. Joule, but, as he is still alive, only a few pages are given to him. His great work, however, on the mechanical equivalent of heat, and his speculations and calculations on the motions of atoms of gases, are so well known that it is needless to recapitulate them here. Only a few scanty extracts are given of Joule's writings, as is also the case with Dalton. To the exclusion of less important matters had the writings of these two representatives of science been more liberally inserted, we think the volume would have gained in interest.

In a concluding chapter Dr. Smith gives a short and explicit account of the present state of the Manchester Society, and of the obstacles that are gradually rising with regard to want of new buildings and money matters, which prevent it taking its proper position and accomplishing the amount of good that is to be expected of a scientific centre in a district swarming with life and activity.

Dr. Smith's work is, as we have already remarked, of essentially local interest, but nevertheless forms a valuable contribution to the historical literature of science, and may be looked upon as a work of reference to the more important memoirs read at the Manchester Society, since its commencement one hundred years ago. We wish the Society every success in the reforms that are contemplated, and that it may survive for another and many more centuries in the struggle for existence amidst the numerous scientific societies and institutions that are now arising.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 1, January 5, 1884.

Remarks on Thermo-chemical Data.—M. Berthelot.—The author comments on the agreements and disagreements existing between his results and those of M. Thomsen, and complains that the latter shows a disposition to make the most of the occasional discrepancies and to charge him with inaccuracy.

Researches on Nitrogen Iodide.—Antony Guyard.—This memoir has already appeared at greater length in the *Moniteur Scientifique* of November last.

Researches on the Double Copper and Nitrogen Iodide.—A. Guyard.—This paper also is an abridgment of one which has appeared in the *Moniteur Scientifique* for November last.

Action of Iodine upon Potassium Seleno-cyanide.—A. Verneuil.—The result of the reaction is a compound $C_6N_3KSe_8$, which is obtained in brilliant red crystals, of a disagreeable odour. They are decomposed at once by water, but more gradually by moist air, yielding potassium seleno-cyanide and selenium. They are also destroyed by a temperature of 120°, leaving the same products, whilst cyanogen is given off. If this compound is treated with absolute alcohol selenium is deposited, and there remains in solution a new compound of the composition $C_6N_3KSe_6$, corresponding to a persulphocyanogen, in which the hydrogen is replaced by potassium.

The "Emetics" of Mucic and of Saccharic Acid.—D. Klein.—The term emetic is here used not in its medical sense but as the generic name of a class of bodies of which tartar emetic, –the double antimony and potassium tartrate—is the type. It does not appear whether either of these compounds can be used in dyeing and tissue-printing in place of the double tartrate.

Determination of the Tannin in Vegetable Substances, especially in the Barks of the Oak, Birch, Fir, Quebracho, Cinchona, in Dividivi, and in Galls, &c.—M. Perret.--Inserted in full.

Cosmos les Mondes,
No. 15, December 8, 1883.

Process for obtaining a very Fine Iridescent Metallic Colour.—Dissolve 64 grms. of common salt in 130 grms. of water, and add 30 grms. nitric acid. The mixture is then poured hot upon a sheet of tinned iron laid upon a stoneware vessel. When the process has been repeated several times the plate is washed in acidulated water. [Where is the novelty?]

Measurement of Electromotive Forces.—M. E. Regnier.—This memoir requires the accompanying illustrations.

Nos. 17, 18, Dec. 22 and 29, 1883, and No. 1, Jan. 5, 1884
These issues contain no chemical matter.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
Vol. 16, No. 7.

Silver Nitrate and Ammonia.—A. Reychler.—In addition to the two compounds of silver nitrate and ammonia already known, the author describes a third, O_2NONH_3Ag. He examines also the brown precipitate obtained by adding ammonia to a neutral or faintly acid solution of silver nitrate, and gives a preliminary notice of a compound obtained on submitting a concentrated solution of silver-ammonium nitrate to dialysis, and a precipitate, argentamin-aldehydate (?), formed on adding an aqueous solution of silver-ammonium-nitrate to aldehyd.

Iso-benzil.—H. Klinger.—Iso-benzil crystallises from alcohol in shining leaflets and needles, and from ether in compact crystals, which melt at 155° to 156°. Its solution in carbon disulphide is decomposed by bromine with the formation of ordinary benzil and benzoyl-bromide.

Basic Double Salts.—H. Klinger.—The author's attempts at obtaining basic lead-cadmium nitrates were not successful. He produced double basic salts of mer-

cury and lead with lime by adding mercury and lead oxides to boiling solutions of calcium chloride or nitrate.

A New Reaction of the Tellurium Compounds.—E. Divers and M. Shimosé.—Already inserted.

History of the Sulphonic Acids of Para-cymol.—A. Claus.—Reference to a recent controversy.

Oxidation of Penta-chlor-naphthaline.—A. Claus and H. v. d. Lippe.—The authors find that the trichlor-naphthoquinon of Claus and Spruck is not genetically connected either with tetra-chlor-phthalic acid or with penta-chlor-naphthaline, but is formed merely as a by-product of *α*-dichlor-naphthaquinon. They describe also tetra-chlor-naphthoquinon.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Centrifugal Machine.—Would any of your readers kindly inform me if centrifugal machines are made of glass? and, if so, what are the makers' names?—Centrifugal.

MEETINGS FOR THE WEEK

Monday, Feb. 18th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.
Tuesday, 19th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
Wednesday, 20th.—Society of Arts, 8. "Reclamation of Land on the North-Western Coast of England," by Hyde Clarke.
—— Meteorological, 7.
—— Geological, 8.
Thursday, 21st.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Chemical, 8. Ballot for the election of Fellows. "An Analysis of Spottley Bridge Spa Water," by H. Peile.
—— Royal Institution, 3. "Music for the Pianoforte, &c." by Prof. Pauer.
—— London Institution, 7.
Friday, 22nd.—Royal Institution, 8. "London (below bridge) N. and S. Communication," by Sir F. Bramwell, at 9.
—— Quekett Microscopical Club, 8.
Saturday, 23rd.—Royal Institution, 3. "Life and Literature under Charles I.," by Prof. Morley.
—— Physical, 3. "On the Adjustment of Resistance Coils; and on a Modified Resistance Balance," by S. P. Thompson, D.Sc. "On the Difference of Potentials required to give Sparks in Air," by Prof. G. Carey Foster, F.R.S.

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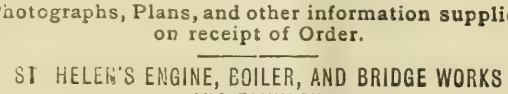

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1265.

ZINC IN DRINKING-WATER.

By C. W. HEATON.

THE water supplied to Cwmfelin, near Llanelly, is drawn from a spring at Penderry, and carried for about half a mile through a galvanised iron pipe. Mr. J. Raglan Thomas, the Medical Officer of Health for the district, detected zinc in the water of this pipe, and sent me samples from the spring and from the pipe for further examination. I obtained the following results :—

	Grains per Gallon.	
	Spring.	Pipe.
Total solids..	10·8	18·9
Chlorine	1·47	1·45
Ammonia	none	0·008
Nitrogen as nitrate	0·056	none
Zinc carbonate in solution in carbonic acid	none	6·41

The solvent action upon zinc of water containing dissolved oxygen and free carbonic acid is, as the above figures show, considerable. As far as I know it has not been observed before.

I confirmed the analysis by a simple experiment. Distilled water containing some fragments of pure zinc was exposed for about half an hour to a stream of oxygen and carbonic anhydride. The filtered liquid was found to contain much zinc in solution, this zinc being readily precipitated as carbonate on boiling.

It will be seen that the Penderry water is very pure. The reduction of the nitrate to ammonia by the action of the zinc is a noteworthy feature in the case.

Charing Cross Hospital,
February 15, 1884.

ON A WEIGHT VOLTAMETER FOR MEASURING ELECTRIC CURRENTS.

By LAURENCE N. LEDINGHAM.

WHILE experimenting on apparatus for measuring electric currents, the idea of doing so by means of a weight voltameter suggested itself as being a method which, at all events, would have the advantage of being constant and unaffected by external agents, as temperature, pressure, magnetism, &c. The following is a brief description of one of the forms which I constructed and experimented with.

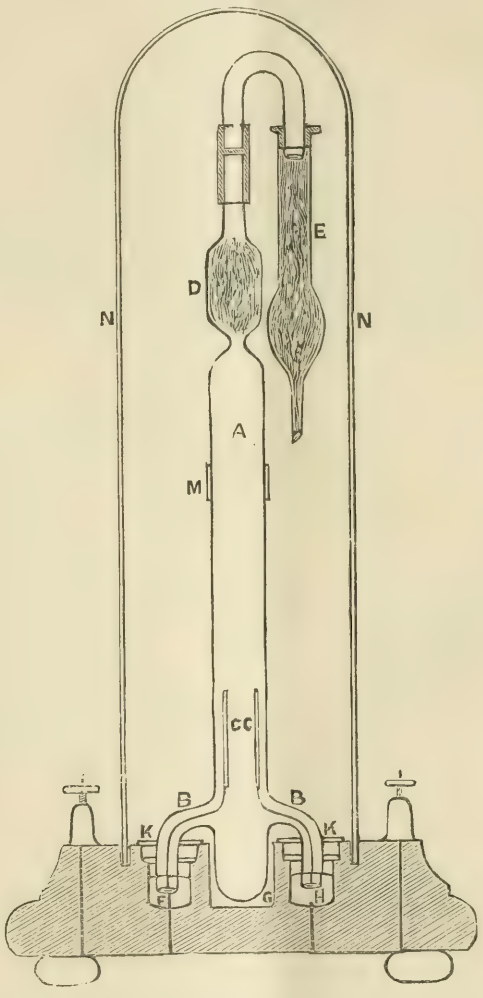
Description.

It consists, as will be seen from the drawing, of a glass tube, A, provided with two arms, B B, containing the platinum wires, which are welded to and support the electrodes, C C; the bulb, D, is filled conveniently with pieces of thin glass tube; these serve to keep sparks of water from being mechanically carried over into the drying tube, E, containing chloride of calcium.

The stand has three circular cavities, F, G, and H. G holds the bottom of the voltameter, and F H accommodate its arms, B B. F and H contain mercury, and are connected with copper wires to the binding screws, I I; they are fitted on the top with round pieces of sheet rubber, which are fastened to and kept in their places by means of small portable wooden rings, K K. These rubbers being slit nearly across form valves, which permit of the apparatus being shifted about without loss of mercury, at the same time freely admitting the arms, B B. These mercury pools form a cool and reliable connection, and to a great extent do away with the inconveniences and risks tending the direct connecting of the terminals with the platinum wires, as notably the heating of the junctions and the cracking of that part of the glass into which the wires supporting the electrodes are fused. N N represents a 9-inch glass shade.

Taking a Measurement.

The terminals of the wires, through which the current to be measured flows, are fixed in the binding screws, I I, and the voltameter freed from air by allowing the elec-



trolysis to proceed for a minute or so; it is now suspended from a balance by a wire, then placed in the spring clip, M; at a noted time the circuit is completed by pressing the arms, B B, into the mercury pools, F and H. The electrolysis is continued for some minutes, when, at a noted second, the current is broken by raising B B out of the mercury. The voltameter is again weighed; the difference gives the *exact amount of water electrolysed.*

Now, by referring to the known fact that, "the amount of water electrolysed in a given time is exactly in proportion to the current strength, and a unit current decomposes 0·0000945 of a grm. water in one second," the current strength, then, in Ampères is got by dividing the

weight of water electrolysed by the constant 0·0000945, multiplied by the time taken reduced to seconds.

Thus, $C \times t \times 0{\cdot}0000945 = \text{Wt. water decomposed.}$

$$\therefore\ C = \frac{\text{Weight water decomposed.}}{0{\cdot}0000945 \times t.}$$

Let W_1 = Original weight of voltameter.
W_2 = Weight after passage of current.
T = Time in seconds.
C = Current in Ampères.

Then, $W_1 - W_2 = \text{Wt. of water electrolysed.}$

$$C = \frac{W_1 - W_2}{0{\cdot}0000945 \times T}$$

Example—

$W_1 = 52{\cdot}3215$ grms.
$W_2 = 52{\cdot}2199$,,
$T = 600$ seconds.

$$\therefore\ C = \frac{52{\cdot}3215 - 52{\cdot}2199}{0{\cdot}0000945 \times 600} = 1{\cdot}791 \text{ Ampères.}$$

Note.—This form of voltameter is not adapted for the measurement of very strong currents, but rather for laboratory and experimental work, where accuracy and constancy are of first importance. When the liquid (acidulated with sulphuric acid) requires renewing, the apparatus is held by A in the warm hand, by which means some of the gases or air will be expelled. If, now, a little water (free from acid) be dropped into D, it will, on removal of the hand, be sucked into A.

Govan, Feb. 16, 1884.

COAL-GAS AS A LABOUR-SAVING AGENT IN MECHANICAL TRADES.*

By THOMAS FLETCHER, F.C.S.

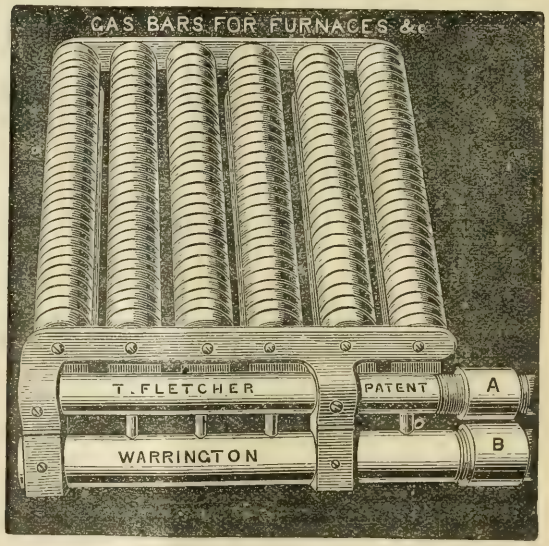
(Concluded from p. 76).

In such processes as the roasting of coffee, chicory, grain, &c., a diffused heat is necessary, but of much greater intensity than can be obtained with economy from heated air. In these cases the application of a direct flame is necessary, and it may be in actual contact with the substances to be heated, provided these are kept in constant and rapid motion.

The use of a revolving cylinder brings in complications with any burner which is supplied with gas at ordinary pressures without any artificial air supply, as the currents of air caused by the motion of the cylinder interfere with the satisfactory working of any burner, and the air supply must be either protected from draughts and irregular air currents, or the air must be supplied artificially from some independent source. One exceedingly good way of making any burner work, independently of the currents caused by a revolving cylinder, is to apply the flame inside the cylinder at the centre, making the substances to be heated to fall in a continuous stream through the flame. This system is not applicable to fine powders, or sticky substances, as it necessitates the perforation of the cylinder, to allow of the escape of products of combustion.

For this class of work, a very concentrated heat is not desirable, as a rule, and a slit, or perforated burner is preferable. Of this class of burner I have here a sample, which is not only new in its constructive details, but has great and special advantages for many purposes. Fig. 2 resembles a number of ordinary furnace bars, with this difference, that each bar is a burner; in fact, it is an ordinary furnace grate, which supplies its own fuel. With the usual day pressure of gas, = 1 inch of water, this burner will, at its maximum power, consume about 100 cubic feet of gas per hour, per square foot of burner surface, and as it can readily be made almost any form or size, its adaptability for a great number of uses is evident. I have made it in many sizes and shapes, to give flames from ½ inch wide by 5 feet long to large square or oblong blocks. By applying a blast of air at the ordinary gas jets, and supplying the gas by a separate pipe, or series of pipes, below the open end of the burner, this can be converted into a furnace of extraordinary power. It is quite possible to burn as much as 2000 cubic feet of gas per hour, per square foot of burner surface, producing a heat sufficient to fuse any ordinary crucible. You see its power when I place a bundle of iron wire in the flame; it is, in fact, a concentration of hundreds or thousands of powerful blowpipe flames in one mass. It has also this advantage, that with a blast of air it will burn and work equally well any side up, and the flames can therefore be directed straight on their work without loss. It is, in one form or another, almost a universal burner, as it can be readily adapted to almost any purpose, from tempering a row of needles to making steam for a 200 horse-power steam-engine. It is easy to make, easy to manage, practically indestructible, and for commercial purposes has, I think, a general adaptability which will bring it, in one form or another, into almost universal use. I may say that when we are in a special fix, this has in every case landed us out of the difficulty.

Fig. 2.



For heating large plates of metal equally, for drying paper impressions for stereotypers, hot-pressing hosiery, crumpet baking, working up plastic masses which can only be worked hot, and work of this class, a number of separate flames equally diffused under the whole surface of the plate are necessary to equalise the heat, unless the plate is very thick, and these are better if produced by a mixture of gas and air, but in heating wide plates one difficulty must always be remembered, the burnt gases from the centre flames can only escape by passing over the outer flames, and therefore a space must be left between the top of the flame and the plate, or the outer flames will be smothered and make a most offensive smell.

In hosiery presses, printers' arming presses, and many others, the top plate also requires to be heated. The best way to do this is to use a number of blowpipe flames directed downwards. In many cases the supply of air under pressure is a practical difficulty and objection. This is overcome, to a certain extent, by the use of a thick upper plate with a number of horizontal holes, into which a Bunsen flame is directed. In every case I have seen,

* A paper read before the Society of Arts, January 30, 1884.

without one single exception, the holes are either too small, or the burner is placed too close, and the consequence is that the gas, instead of burning inside the holes, as it should, passes through partially unburnt, and is consumed at the opposite end, where it is absolutely useless, the flame not being in contact with or under the surface to be heated, and therefore doing no work. In hosiery presses this is a great objection, as the holes are so long that an equal heat is simply impossible, and the only remedy is to use a blowpipe flame, which forces sufficient air in with the gas to ensure combustion where the heat is necessary. The same remark applies to crape and embossing rollers.

For the production of heat in confined spaces and difficult position the use of an artificial blast of air is becoming an acknowledged necessity, and the small Roots blowers now made for such purposes, and driven by power, are coming rapidly into use.

Sometimes a plate is required to be heated to a high temperature in one confined spot, and, as an example of this, I may take the blueing of the hands of watches. For this purpose I have made several arrangements, and perhaps the best is a thin copper plate, bent down at one side to a right angle. In this angle, underneath is directed a very fine blowpipe flame on one spot, and the hands are passed singly over this spot until the colour comes, when they are instantly pushed over the edge. I have here the arrangement which is generally used for this purpose. For the blueing of clock hands, a larger and more equally heated surface is required, and this can be obtained by a small powerful burner without a blast of air, using a rather thicker plate to equalise the heat (Fig. 3). The same arrangement may be used with advantage for tempering small cutters for ornamental turning, penknife blades, &c., and in these cases the cooler part of the plate is of great value, as it enables the thicker parts to be slowly and equally heated up; the application of a mechanical arrangement to pass the articles to be heated in a regular succession is a matter easily managed.

Fig. 3.

Among other things which have several times come under my notice, may be mentioned cremation furnaces, but I have not yet met with, or been able to devise, any burner for ordinary coal-gas which has worked satisfactorily. This fuel is apparently unfitted for the work, and the best arrangement I know is a number of pipes delivering ordinary "producer" gas from the Wilson or Dowson generators, in exactly the same way as is at present used for firing horizonal steam boilers. For heating bookfishers' tools, a ring-flame is the simplest, the tools being supported a little distance above the flame; the usual plan of heating a plate, and placing the ends of the tools on this, necessitates at least double the gas consumption as compared with an open flame. For type-founding machines, bullet moulding, stereotype metal melting, solder making, lead melting, &c., one burner, or rather one flame, should be used of a suitable power for the work, and this should be as perfect and of as high a temperature as possible to ensure economy. It is now a simple matter, owing to recent researches in the theory of heating burners, to obtain flames of any power without practical limit, which, without any artificial air supply, will do all which is necessary in this class of work, and the required arrangements are exceedingly simple. With these trades may be classed, also, the concentration and distillation of acids and liquids boiling at a high temperature, and we may also include baths for tinning small articles, and the tinning by fusion of sheet copper, the same burners being applicable, and perfectly suited to all these requirements, unless the tinning baths are long and narrow, in which case the furnace-bar burners again come to the front as the best; as, if we are to use gas economically, the flame must be the same shape as the vessel to be treated.

Fig. 4.

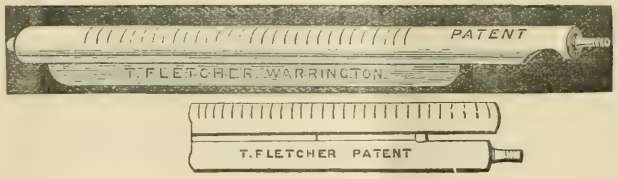
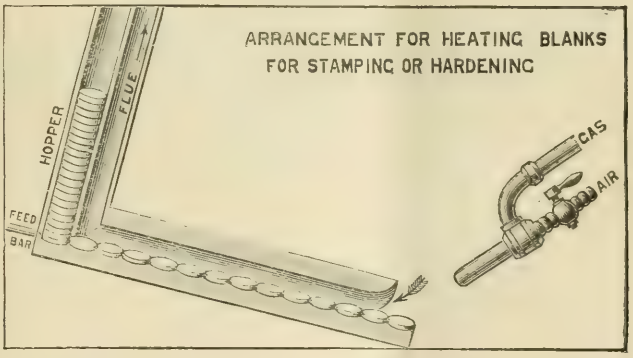


Fig. 5.



We may now consider the heating of blanks for stamping, hardening the points of spindles, finishing the ends of umbrella tips, and work where a small article, or a small part of any article, has to be heated to a high temperature with speed and certainty. For these a long and narrow flame is necessary, and I may mention that in cases where a high speed of delivery is required, and a small part only has to be heated, such as, for instance, in the hardening of the points of spindles for cotton machinery, I have made burners giving a flame of exceedingly high temperature only ¼-inch wide and 5 ft. long. This flame is produced by the assistance of a blast of air, and is of a sufficiently high temperature to fuse the spindle in a few minutes. (Fig. 4).

The points only project over the flame, and the spindles are carried mechanically at such a speed that at the end

of the 5 ft. traverse they are red-hot, and drop into water. More than one hundred are in the flame at once, lying side by side.

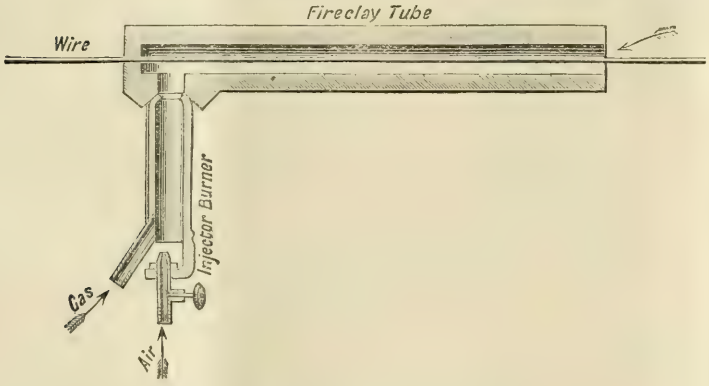
For heating blanks for stamping, the furnace bar-burner is perfectly suited, and in this work the shoot supplying the blanks to the machine should be made of two fireclay sides, with an opening for the flame between the shoot and flame being placed at a sharp angle, to prevent risks of the blanks sticking or over-riding each other. A blowpipe may also be used with good effect, as shown in Fig. 5, and in many cases it is preferable and much easier to manage.

In some cases, the direct contact of the flame would spoil the articles to be heated, and instead of the arrangement mentioned, a tube of iron, fire-clay, or other suitable material is heated, and the articles are passed through it. This system of continuous feed, through a tube, has been applied to the firing of small articles of pottery, and might possibly be well adapted, amongst other things, to the production of gas-burners.

Where the contact of air with the heated article is injurious, many plans have been tried to keep the ends closed as much as possible, but I believe no more perfect and simple seal against the admission of air can be devised than to turn a jet of pure gas, unmixed with air, into each end of the tube. This is an absolute seal against the entry of oxygen in an uncombined state; free oxygen cannot exist at a very high temperature in the presence of coal-gas.

For many trades there is a demand for hardened and tempered steel wire, either round or flattened, and the production of this has led to many attempts to obtain a satisfactory continuous process. The common method now, which is worked as a "secret" process by most firms,

Fig. 6.



is to pass the wire through a tube to heat it, as already described, and to run it direct from the tube through a hole in the side of a box filled with oil, the hole being packed with asbestos, to prevent leakage; from this it is passed through another similar hole on the opposite side, either over a plate heated to the right temperature, or over a narrow open flame of sufficient length and power to give the correct heat for tempering.

Where absolute precision is necessary, the gas supply must be adapted by an automatic regulator on the main, to prevent the slightest variation of heat. Once adjusted the production of flat and round spring wire by the mile is an exceedingly simple matter. It is quite possible to obtain absolute precision in temperature by a proper adjustment of the gas pressure, and as this is, for tempering steel articles and some other purposes, a matter of great importance, it is worth some consideration. No pressure regulator alone will give an absolutely steady supply; but if we put on first a regulator, adjusted to the minimum pressure of supply, say 1 inch of water; and then fix another on the same pipe, adjusted to a slightly lower pressure, say 9-10ths of an inch, the first regulator does the rough adjustment, and the second one will then give an absolutely steady supply, providing always that the regulators are both capable of passing more gas than is likely to be ever required. No regulator can be relied on for absolute precision, if worked up to its maximum possible capacity.

Amongst other applications of a long narrow flame of high power, may be mentioned the brazing of long lengths of tube, in fact the application of flames of this form, with and without a blast of air, for different temperatures, are almost endless.

The thousands of uses to which blowpipes are adapted are so well known that they need no mention, except the curiously ignored fact that the power of any blowpipe depends on the air pressure. A compact flame of high temperature cannot be obtained except with a heavy air pressure, and the ignorance of this fact has caused an immense number of unexplained failures. Many people think that one blower is as good as another, and expect that a fan giving a pressure equal to, say, the height of a 2 inch column of water, should do the same work as a blower giving a pressure ten to twenty times as great. The construction and power of blowpipes, with the laws ruling the proportions and power, will be found in an article on "Blowpipe Construction," published in *Design and Work*, March, 1881, and as the matter is there fully treated, no further reference to the subject is necessary.

In the more recent forms of gas-engine, the charge is exploded by a wrought-iron tube, heated to redness by the external application of a gas flame. This, although considered satisfactory by the makers, appears to me to be an exceedingly crude way of getting over the difficulty; and I offer it as a suggestion, that a very small platinum tube shall be used instead of iron. This, if made with a porous or spongy internal coating, would fire the charge with certainty, at a lower temperature than iron, and it could be made so thin and small in diameter, without risk of deterioration or loss of strength, that an exceedingly small flame could be used to heat it up. As it would be fully heated in a very few seconds, the delay in starting would be obviated. (Fig. 6.)

There are many purposes for which a red heat is needed for slow continuous processes on a small scale, such as case-hardening small steel goods, annealing, heating light steel articles for hardening, and a great variety of other similar processes. This, until recently, has required the use either of a rather complicated furnace or a blast of air under pressure, to increase the rapidity of combustion. Since the conclusion of my experiments on the theoretical construction of burners, I have found that the high-power burners, previously described, are capable of heating a crucible equal in size to their own diameter to bright redness without the assistance of a chimney, provided the crucible is protected from draughts by a fireclay cylinder.

This is an important point, as it renders the production of a continuous bright red heat a matter of the greatest ease, even in crucibles of a comparatively large size. Where the heat is steady, and certain not to rise above a definite point, it can safely be used for such purposes as hardening penknife blades, and other articles which are very irregular in thickness, the thin edges not being liable to be burnt or damaged by over-heating.

For the highest temperatures air under pressure is a necessity, as we require a large quantity of gas burnt in as small a space as possible with the maximum speed, and, given this air supply, we are very little hampered by conditions, as an explosive mixture may be blown through a gauze into a fireclay chamber, closed, except so far as is necessary to allow the escape of burnt gases. The speed of combustion is limited only by the speed of supply

of air and gas, and by increasing these there is no practical limit to the heat which can be obtained. When we have to do with the reduction of samples of refractory ores, testing the comparative fusibility of different samples of firebricks, or alloys, &c., the use of an explosive mixture blown into and burning in a close chamber is invaluable, and the ease and certainty with which any temperature may be obtained has led to great discoveries and the revolutionising of many commercial processes. Recent experiments have proved that, by a modification in the form of the well known injector furnace, an enormous increase of temperature may be obtained. I have, in actual work, obtained the fusing-point of cast-iron in two minutes, starting all cold, and have fused every furnace casing I have yet been able to produce. If infusible casings can be made, I think I am not overstating facts in saying that any temperature required can and will eventually be obtained with the greatest ease. What the limit is I have as yet not been able to discover.

There is one more application of gas, as a fuel, which, dlscovered and published by myself some two years ago, has yet to become generally known, and in some special processes may prove exceedingly valuable. This is the addition of a very small quantity of coal-gas, or light petroleum vapours, to the air supplied by a blower or chimney pull, to furnaces burning coke or charcoal. The instant and great rise in temperature of the furnace, and the greater stability of the solid fuel used, are extraordinary. This is, in fact, a practical application of the well-known "flameless combustion," the only signs that the gas is being burnt being a great rise in temperature and a decreased consumption of the solid fuel; in fact, if the gas is in correct proportion, the solid fuel remains unburnt, or nearly so, in spite of the high temperature. In cases where a sudden rise of temperature is required in a furnace, or where the power is deficient, this method of supplementing and increasing the heat will be found of very great service, and processes liable to be checked by making up a fire with fresh fuel can be carried on without check, even after the solid fuel has almost entirely disappeared.

That a solid fuel is quite unnecessary I will prove in a very simple manner, by burning a mixture of coal-gas and air without a flame in a bundle of iron wire. The heat is sufficient to fuse the wrought-iron with ease, and the glare inside the bundle of wire is painful to the eyes. The same result could be obtained by a pile of red-hot lumps of firebrick, and the same heat obtained also without a trace of flame.

It is not possible to enter fully into such a wide and important subject in a single lecture, and the suggestions now given are simply hints for the guidance of those who need or desire to experiment. No doubt we shall have, after a time, some text-books and other literature on this subject, which is one of great importance to many industries; and it is necessary for experimental work and applications to new industries that the experimenter shall not only be able to purchase special burners, but that he shall have fundamental laws laid down which will enable him to construct them for himself, so as to have his experiments under his own control. The difficulty in the way of literature on the subject is that those few who have worked in the matter are busy men, with little time which is not already fully employed.

Pioneers on new ground have a great liability to generalise and jump at conclusions, and the necessary exact work and detail must, to a great extent, be left to those who follow on tracks already roughly marked out.

Of the special trades which have come under my observation I have only had time to mention a very few. It appears to me that there are very few manufacturing processes of any kind, which could not be simplified by the use of gas as a fuel, from the production of electric light apparatns to the manufacture of explosives, cotton stockings, beer, catgut, glue, umbrellas, ink, fish-hooks, medals, stained glass windows, brushes, and other trades equally various, which come daily under my own notice.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

MOLYBDENUM.

If we leave out of account the inaccurate determination made by Berzelius,† we shall find that the data for the atomic weight of molybdenum lead to two independent estimates of its value; one near 92, and the other near 96. The earlier results found by Berlin and by Svanberg and Struve lead to the lower number; the more recent work of Debray, Dumas, and Lothar Meyer sustains the higher. The latter value is the more probable, although both may be vitiated by constant errors in opposite directions.

The earliest investigation which we need especially to consider is that of Svanberg and Struve.‡ These chemists tried a variety of different methods, but finally based their conclusions upon the two following:—first, molybdenum trioxide was fused with potassium carbonate, and the carbon dioxide which was expelled was estimated; secondly, molybdenum disulphide was converted into the trioxide by roasting, and the ratio between the weights of the two substances was determined.

By the first method it was found that 100 parts of MoO_3 will expel the following quantities of CO_2:—

31·4954
31·3749
31·4705

Mean 31·4469 ± 0·0248

The carbon dioxide was determined simply from the loss of weight when the weighed quantities of trioxide and carbonate were fused together. It is plain that if, under these circumstances, a little of the trioxide should be volatilised, the total loss of weight would be slightly increased. A constant error of this kind would tend to bring out the atomic weight of molybdenum too low.

By the second method, the conversion by roasting of MoS_2 into MoO_3, Svanberg and Struve obtained these results. Two samples of artificial disulphide were taken, A and B, and yielded for each 100 parts the following of trioxide:—

89·7919	A.
89·7291	A.
89·6436	B.
89·7082	B.
89·7660	B.
89·7640	B.
89·8635	B.

Mean 89·7523 ± 0·0176

Three other experiments in series B gave divergent results, and, although published, are rejected by the authors themselves. Hence it is not necessary to cite them in this discussion. We again encounter in these figures the same source of constant error which apparently vitiates the preceding series, namely, the possible volatilisation of the trioxide. Here, also, such an error would tend to reduce the atomic weight of molybdenum.

Upon discussing the data given in the foregoing paragraphs we get somewhat noticeable results. From the carbon dioxide series, Mo = 91·711 ± 0·113, a figure having no unusual interest. From the other series, if S = 31·987 and O = 15·9633, we get Mo = 92·979 ± 0·354; but if we take S = 32 and O = 16, then Mo becomes = 92·133. In this case the higher values for oxygen and sulphur lead to a lower number for molybdenum. In the car-

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1. 1826.
‡ *Journ. f. Prakt. Chem.*, 44, 301. 1848.

bonate series the assumption of 12 and 16 for C and O, respectively, makes Mo=92·033. In other words, if we assume the ordinary even numbers for C, O, and S, Svanberg and Struve's two methods yield more nearly concordant results than when the revised values for these elements are taken.

Berlin,* a little later than Svanberg and Struve, determined the atomic weight of molybdenum by igniting a molybdate of ammonium and weighing the residual MoO_3. Here, again, a loss of the matter by volatilisation may (and probably does) lead to too low a result. The salt used was $(NH_4)_4Mo_5O_{17}.3H_2O$, and in it these percentages of MoO_3 were found :—

81·598
81·612
81·558
81·555

Mean 81·581 ± 0 0095

Hence Mo=91·9817 ± 0·0776; a result agreeing quite well with those of Svanberg and Struve.

Until 1859 the value 92 was generally accepted on the basis of the foregoing researches, but in this year Dumas† published some figures tending to sustain a higher number. He prepared molybdenum trioxide by roasting the disulphide, and then reduced it to metal by ignition in hydrogen. At the beginning the hydrogen was allowed to act at a comparatively low temperature, in order to avoid volatilisation of trioxide; but at the end of the operation the heat was raised sufficiently to insure a complete reduction. From the weighings I calculate the percentages of metal in MoO_3 :—

0·448 grm.	MoO_3 gave	0·299 grm.	Mo.	66·741 per cent.
0·484	,,	0·323	,,	66·736 ,,
0·484	,,	0·322	,,	66·529 ,,
0·498	,,	0·332	,,	66·667 ,,
0·559	,,	0·373	,,	66·726 ,,
0·388	,,	0·258	,,	66·495 ,,

Mean 66·649 ± 0·030

In 1868 the same method was employed by Debray.‡ His trioxide was purified by sublimation in a platinum tube. His percentages are as follows :—

5·514 grms.	MoO_3 gave	3·667 grms.	Mo.	66·503 per cent.
7·910	,,	5·265	,,	66·561 ,,
9·031	,,	6·015	,,	66·604 ,,

Mean 66·556 ± 0·020

This mean, combined with that of Dumas's, gives a general mean of 66·585 ± 0·017.

Hence Mo=95·429 ± 0·057.

Debray also made two experiments upon the precipitation of molybdenum trioxide in ammoniacal solution by nitrate of silver. In his results, as published, there is curious discrepancy, which, I have no doubt, is due to typographical error. These results I am, therefore, compelled to leave out of consideration. They could not, however, exert a very profound influence upon the final discussion.

The most recent investigation upon the atomic weight of molybdenum is the discussion by Lothar Meyer‖ of the experimental results obtained by Liechti and Kemp§ in their analyses of the chlorides. Of these compounds there are four :—$MoCl_2$, $MoCl_3$, $MoCl_4$, and $MoCl_5$. The chlorine in each was estimated as silver chloride, and the molybdenum as disulphide. From these analyses Meyer deduces three sets of ratios, namely :—between $MoCl_n$ and nAgCl; between $MoCl_n$ and MoS_2, and between MoS_2 and nAgCl. We will use only the first and last of these; the probable error of the atomic weight deduced from the second being relatively so high as to make the value connected with it comparatively unimportant. The analyses of the trichloride, being discordant, are here rejected.

By reducing the weighings published by Liechti and Kemp* to a common standard we get the following percentage results. In $MoCl_2$ the subjoined quantities of the original substance and of MoS_2 correspond to 100 parts of AgCl :—

$MoCl_2$.	MoS_2.
58·299	55·762
58·194	55·591
58·524	56·065
Mean 58·339 ± 0·066	Mean 55·806 ± 0·093

Hence $MoCl_2$=166·902 ± 0·188, and MoS_2=159·652 ± 0·268.

With the tetrachloride similarly calculated we get these figures, corresponding to 100 parts AgCl :—

$MoCl_4$.	MoS_2.
41·492	27·957
41·319	
Mean 41·4055 ± 0·0583	

Hence $MoCl_4$=236·914 ± 0·358, and MoS_2, if given the weight of a single experiment in the dichloride series, =159·964 ± 0·627.

For the pentachloride the following quantities balance 100 of AgCl :—

$MoCl_5$.	MoS_2.
38·168	22·428
38·057	22·289
Mean 38·112 ± 0·038	Mean 22·3585 ± 0·040

Hence $MoCl_5$=272·587 ± 0·271, and MoS_2=159·914 ± 0·287.

We have now the molecular weight of each chloride, and three values for that of the disulphide. Combining the latter we get a general mean, as follows :—

From $MoCl_2$ series ..	MoS_2=159·652	± 0·268
,, $MoCl_4$,, ..	,, 159·964	0·627
,, $MoCl_5$,, ..	,, 159·914	0·287
General mean ..	,, 159·790	0·187

With these data, in addition to those given by Dumas and by Debray, we get five estimates of the atomic weight of molybdenum : –

Dumas and Debray's data	Mo=95·429	± 0·057
From molecular weight of $MoCl_2$..	,, 96·262	0·190
,, ,, $MoCl_4$..	,, 95·434	0·363
,, ,, $MoCl_5$..	,, 95·737	0·280
,, ,, MoS_2 ..	,, 95·816	0·188
General mean ..	,, 95·527	0·051

Or, if O=16, Mo=95·747.

It will at once be seen that the most reliable results are those obtained by the reduction of molybdenum trioxide. Traces of oxychlorides may possibly have contaminated the chlorides and augmented their atomic weight. Our final figure, therefore, may be a trifle too high, but the early value, 92, is unquestionably very far too low.

* These are as follows :—

0·2666 grm.	$MoCl_2$ gave	0·2550 grm.	MoS_2 and	0·4573 grm. AgCl.
0·1811	,,	0·1730	,,	0·3112 ,,
0·2530	,,	0·2422	,,	0·4320 ,,
0·4126 grm.	$MoCl_4$ gave	0·2780	,,	0·9944 ,,
0·1923	,,	—	,,	0·4654 ,,
0·5810 grm.	$MoCl_5$ gave	0·3414	,,	1·5222 ,,
0·2466	,,	0·1441	,,	0·6465 ,,

† *Journ. f. Prakt. Chem*, 49, 444. 1850.
‡ *Ann. Chem. Pharm.*, 105, 84, and 113, 23.
§ *Compt. Rend.*, 66, 734.
‖ *Ann. Chem. Pharm.*, 169, 365 1873.
§ *Ann. Chem. Pharm.*, 169, 344.

Since the foregoing discussion was written, a single experiment by Rammelsberg* has been brought to my notice. Closely following Dumas's method, he reduced molybdenum trioxide to metal, finding in it 66·708 per cent of the latter. This figure comes within the limits of variation of Dumas's experiments, and therefore gives them additional confirmation. Its introduction into the general mean, however, would exert too little influence upon the latter to justify the labour of recalculation.

THE CHEMICAL WORK OF WÖHLER.*

By Professor THORPE, F R.S.

It seems fitting that these walls which have vibrated in sympathy with that brilliant eulogy of Liebig, which Professor Hofmann pronounced some nine years ago, should hear something of him whose life-long association with Liebig has exercised an undying influence on the development of scientific thought. The names of Frederick Wöhler and Justus Liebig will be linked together throughout all time. The work which they did in common makes an epoch in the history of chemistry. No truer indication of the singular strength and beauty of their relations could be given than is contained in a letter from Liebig to Wöhler written on the last day of the year 1871. "I cannot let the year pass away," writes Liebig to Wöhler, "without giving thee one more sign of my existence, and again expressing my heart-felt wishes for thy welfare and the welfare of those that are dear to thee. We shall not for long be able to send each other new year's greetings, yet, when we are dead and mouldering, the ties which have united us in life will still hold us together in the memory of men as a not too frequent example of faithful workers, who, without envy or jealousy, have zealously laboured in same field, linked together in the closest friendship."

And yet, bound as they were in the ties of a friendship whose purity and warmth were but characteristic of the men, and although each influenced the other's walk and work in life to a degree which it is almost impossible to gauge, such was the strength of their individuality, and such the force of their genius, that, without a doubt, either would have been a great figure in the history of science if the other had not existed.

The conditions under which minds of the highest type arise and develop have on more than one occasion engaged the attention of this audience. Although there were circumstances in Wöhler's surroundings which in early life may have influenced the bent of his mind, it is not easy to see whence spring that passionate love of nature which was so strikingly exhibited in the man. His father, August Anton Wöhler, was formerly an equerry in the service of the elector William II. of Hesse; he afterwards came to live at Frankfort and became a leading citizen of that town. His wise liberality and public spirit are commemorated in the Wöhler-Foundation, and Wöhler-School, institutions known to every Frankforter. His mother was connected by marriage with the minister of Eschersheim, a village near Frankfort, and it was in the minister's house that Frederick Wöhler first saw the light on the 31st July, 1800. Even in early youth his passion for experimenting and collecting manifested itself to the neglect, not unfrequently, of the lessons of the Gymnasium; indeed it would appear that during his school career Wöhler was not characterised by either special diligence or knowledge. The bent of his mind towards natural science was directed by Dr. Buch, a retired physician, who had devoted himself to the study of chemistry and physics; and it was in the kitchen of his patron's house that he prepared the then newly discovered element selenium, of which an account was afterwards sent by Dr. Buch to *Gilbert's Annalen*, with Wöhler's name at the head of it. The elder Wöhler appears to have been a man of considerable artistic feeling, and under his direction, the son was taught sketching and otherwise educated in that perception of natural beauty which comes out so strikingly in his after life; he was encouraged to make himself familiar with the literature which the genius of Schiller and Gœthe has ennobled. He had moreover to thank his father for that love of physical exercise and passion for out-door life which reacted so markedly upon his development, and contributed so largely to the uniformly good health which he enjoyed to within a few days of his death.

Mainly, it would seem, because his father had been there before him, Wöhler, in his 20th year, entered the University of Marburg. It was his own and the family's wish that he should study medicine, and he accordingly put his name down for the lectures of Bünger on Anatomy, Gerling on Physics and Mathematics, and Wenderoth on Botany. He found time also to attend Ullmann's classes on mineralogy, and although he declined to hear the lectures on chemistry, he by no means neglected that science. He transformed his living room into a laboratory, and to the great, and perhaps not undeserved disgust of his landlady, occupied himself with the preparation and study of the properties of prussic acid, thiocyanic acid, and other cyanogen compounds. He discovered at that time, without knowing that Sir Humphry Davy had anticipated him, the beautifully crystalline, but intensely poisonous, iodide of cyanogen, and in the little paper on cyanogen compounds, which his good friend Dr. Buch communicated to *Gilbert's Annalen* for him, we have the first description of the remarkable behaviour of mercuric thiocyanate on heating, which has astonished and amused us in the so-called "Pharaoh's Serpent."

Wöhler, attracted by the fame of Leopold Gmelin, left Marburg for Heidelberg. His main idea was to hear the lectures of that distinguished man, but Gmelin declared this to be unnecessary and a waste of time. Wöhler in fact never attended any systematic lectures on Chemistry. He had access, however, to the old cloisters which at that time constituted the Heidelberg Laboratory, and there began the work on cyanic acid which some four or five years later was destined to culminate in the great discovery of the synthesis of urea. His association at this time with Tiedemann, who was engaged in physiological chemical investigations with Gmelin, had also considerable influence in determining the direction of much of his future work, whilst its immediate effect was the publication in Tiedemann's *Zeitschrift fur Physiologie* of the results of an inquiry into the transformation experienced by various substances, organic and inorganic, in their passage through the organism. In 1823 Wöhler obtained his degree, when, on Gmelin's advice, he determined to follow his master's example and abandon medicine for chemistry. At that time the great Swedish chemist, Berzelius, was at the summit of his fame. His masterly analytical skill, no less than his labours towards the development of chemical theory, had made him supreme among the chemists of Europe and Stockholm; therefore to him Wöhler, acting on the advice of Gmelin, determined to go. He was warmly welcomed by Berzelius, on whom his communications to *Gilbert's Annalen* had made a favourable impression, and with the offer of a place in the private laboratory of the illustrious Swede, Wöhler set out for the Scandinavian capital. Of his experience with Berzelius his pupil has left us a delightful account. It is valuable not only as a charming character sketch of the great teacher, but also from the side-light it throws upon the nature and disposition of Wöhler himself. It is interesting, too, as an account of the mode in which Berzelius worked and taught and as showing how the typical laboratory of that

* *Berlin Monatsbericht*, 1877, 574.

* A Lecture delivered in the Royal Institution on Friday evening, Feb. 15th.

time contrasted with the temples which have since been reared by the disciples of Hermes. "With a beating heart," says Wöhler, "I stood before Berzelius's door and rang the bell. It was opened by a well-clad, portly, vigorous looking-man. It was Berzelius himself. . . . As he led me into his laboratory I was as in a dream, doubting if I could really be in the classical place which was the object of my aspirations. . . . I was at that time the only one in the laboratory: before me were Mitscherlich and Heinrich and Gustav Rose: after me came Magnus. The laboratory consisted of two ordinary rooms furnished in the simplest possible way; there were no furnaces nor draught places; neither gas nor water service. In one of the rooms were two common deal tables; on one of these worked Berzelius; the other was intended for me. On the walls were a few cupboards for the reagents; in the middle was a mercury trough, whilst the glass-blowers, lamp stood on the hearth. In addition was a sink consisting of an earthenware cistern and tap standing over a wooden tub, where the despotic Anna, the cook, had daily to clean the apparatus. In the other room were the balances, and some cupboards containing instruments: close to was a small workshop fitted with a lathe. In the neighbouring kitchen, in which Anna prepared the meals, was a small but seldom-used furnace and the never-cool sand-bath."

Wöhler's first exercises were in mineral analysis, in order that he might become acquainted with Berzelius's special methods and manipulative procedure. At that time he prepared, among other products, some new compounds of tungsten, notably the beautifully crystallised monoxychloride and the tungsten sodium-bronze ($Na_2W_3O_9$), which some twenty-five years later was introduced into commerce as a bronze-powder. It was, however, with his investigation on cyanic acid that both he and Berzelius were mainly interested. In Berzelius's opinion, the existence of this body was of importance from the light it seemed to him to throw upon the validity of the new chlorine theory. "I was surprised," says Wöhler, "to hear him, the hitherto stedfast upholder of the old notion, now always talk of *chlorine* instead of oxidised hydrochloric acid. Once when Anna, in cleaning some vessel, remarked that it smelled strongly of oxymuriatic acid, Berzelius said, 'Hearest thou, Anna, thou must no longer speak of oxidised muriatic acid: thou must call it *chlorine:* that is better.'" With what feelings would Davy have listened to that colloquy between the Swedish philosopher and his factotum! Chlorine was discovered by Berzelius's illustrious countryman, Scheele, but its true nature was first demonstrated in the laboratory of the Royal Institution.

A couple of months were now spent in travel with Berzelius, in company with the two Brongniarts,—Alexander, the geologist, and Adolph, the botanist—during which they explored the greater portion of the geologically interesting parts of Southern Sweden and Norway, and collected rich stores of those wonderful minerals for which Scandinavia is famous. Scandinavia is no less famous for salmon and trout, and it was on his return from a fishing expedition in Norway that the travellers met with Davy, who, as readers of Salmonia know, handled his rod with equal zest and zeal. Wöhler, who as a boy had learned the story from his friend, Dr. Buch, of the isolation of the alkaline metals by Davy, and who, aided by his little sister, whose business it was to blow the bellows, had toiled, not unsuccessfully, to make potassium in the kitchen fire, was presented to the famous chemist.

On the return to Stockholm Wöhler took leave of Berzelius, and prepared to return to Germany. Of his association with this great man Wöhler had ever the kindliest memories. Although the outcome of much of his subsequent work—or at least much of that which he did in concert with Liebig—might be said to bring him in occasional conflict with Berzelius's cherished convictions on points of chemical theory, the master and pupil remained to the end bound together in warmest friendship. Scarcely a month passed without an exchange of letters. Those from Berzelius were religiously preserved by Wöhler, who after Berzelius's death in 1848 presented them, to the extent of some hundreds, to the Swedish Academy of Science. We are told that in the later letters the "trauliche du" appears in place of the more formal "Sie," and that "*totus et tantus tuus*" is a not unfrequent signature. Wöhler's gratitude and almost filial reverence are seen in the circumstance that even in the full tide of his vigour, and when time was doubly precious to him, he continued to charge himself with the yearly translation of Berzelius's *Jahresbericht* into German. It is easy to trace the influence of Wöhler's contact with Berzelius in this after-work. To begin with the men had much in common. Their sympathies were as catholic as science itself, and they ranged at will over every department of chemical knowledge. Wöhler attacked the composition of a mineral with as much ardour as he did the preparation of an organic compound: to him the problems of physiological chemistry were not more important than the isolation of a rare earth or the perfection of some analytical method. The artificial barriers and fancied lines of demarcation in the science seemed to have no existence for Wöhler. Indeed, it was the crowning triumph of his work to break down such barriers almost at a stroke, and to demonstrate the irrationality of these attempts to draw distinctions regardless of differences. The history of chemistry is indeed like that of the nation which has done so much to advance it: its unity to-day is as complete as that of Germany itself.

Wöhler was now to embark on his academic career, and, under the advice of Gmelin and Tiedemann, he prepared to settle in Heidelberg as "Privat-docent." But to Heidelberg he was not destined to go. His worth had already been gauged by such men as Leopold von Buch, Poggendorff, and Mitscherlich, and these, without his knowledge, had strongly recommended his election to the vacant teachership of chemistry in the newly-founded Trade School in Berlin. Berzelius advised him to accept the post, and to Berlin accordingly Wöhler went in 1825. He was now in possession of a laboratory which he could call his own, and he had to justify that possession by the use which he made of it. One of the problems which he now attacked was the isolation of *aluminium*—a metallic radicle more abundant and more widely diffused than any other of the fifty bodies we are accustomed to designate as metals. He succeeded in obtaining the body by the method which nearly twenty years after was worked out on a manufacturing scale by Sainte-Claire Deville. Deville caused the first bar of the metal thus procured to be struck as a medal with the image of Napoleon III. on the one side and the name Wöhler with the date 1827 on the other, and some time after the Emperor simultaneously designated the two chemists Officers of the Legion of Honour. But of the 22 memoirs and papers which *Poggendorff's Annalen* exhibits as the outcome of Wöhler's activity and power of work during his six years' stay in Berlin, that on the artificial formation of urea is by far the most important. No single chemical discovery of this century has exercised so great an influence on the development of scientific thought, and the words with which Wöhler closes his account of the molecular transformation of ammonium cyanate, a body of purely inorganic origin, into urea,—a substance which of all that might be named is the most characteristic of the action of the so-called vital force—a force which some would have us believe rises superior to all forms of energy, inasmuch as it is untrammelled by the laws which regulate their action—are full of meaning. "This unexpected result," he says, "is a remarkable fact, in so far as it presents an example of the artificial formation of an organic body, and, indeed, one of animal origin out of inorganic materials."

"The synthesis of urea," says Professor Hofmann in his account of Wöhler's life-work, "was an epoch-making discovery in the real sense of that word. With it was

opened out a new domain of investigation, upon which the chemist instantly seized. The present generation, which is constantly gathering such rich harvests from the territory won for it by Wöhler, can only with difficulty transport itself back to that remote period in which the creation of an organic compound within the body of a plant or an animal appeared to be conditioned in some mysterious way by the vital force, and they can hardly realise the impression which the building up of urea from its elements then made upon men's minds. And yet it cannot be said that chemists were unprepared for this discovery. Such a consummation was indicated years before by the results of chemical activity. Men were long ago in the habit of perceiving that bodies of mineral origin were but the types of those met with in the animal and vegetable organism. In both classes there were the same differences in states of aggregation, the same mutual transformations, the same crystalline forms, the same constancy in combining relations, the same conjunction of the elements according to the weights of their atoms or in multiples of these, in both classes the appearance of the same species of compounds! But all attempts to build up organic compounds from their elements, as this for a large number of mineral substances had already been done, had hitherto been futile. The chemists of that period had nevertheless the presentiment that even this barrier must fall, and one can conceive the feeling of joy with which the gospel of a new unified chemistry was hailed by the intellect of that time. With the revolution thus effected in the ideas of men, Science was directed into new paths and unto new goals. Who does not know with what zeal these paths have been trodden, and how many of these goals have been reached!"

But if at this time Wöhler made a great discovery for us and for all men, he also, at about the same time, made a great discovery for himself: he discovered Liebig. The manner in which the two men were brought together is worth mentioning, for it would seem almost as if the hand of destiny was in it. At about the time that Wöhler was at Stockholm, thinking and working on cyanic acid, Liebig was at Paris engaged with Gay-Lussac on the study of the metallic compounds of an acid which, on account of their formidable explosive properties, has received the not inappropriate name of fulminic acid. Liebig, with rare skill and courage, had determined the composition of that acid, and had been rewarded by the honour of a waltz with Gay-Lussac, it being the habit of that distinguished philosopher, as he explained to the astonished young German doctor, to express his ecstasy on the occasion of a new discovery in the poetry of motion. But the most extraordinary result of that investigation was to show that the terribly explosive fulminic acid and innocuous cyanic acid were of identical composition. The idea that bodies could exist of identical ultimate composition—that is, composed of the same elements united in the same proportion and yet possess essentially different properties; in other words, be absolutely dissimilar things—was new to science Berzelius, the great chemical law giver of his time, scouted the notion as absurd; to him it was impossible to conceive that identity in elementary composition should not result in identity of properties. And yet, later on, Berzelius was forced to realise the fact by the discovery of his pupil Wöhler of the molecular transformation of ammonium cyanate into urea, and to coin for us the word *isomerism* by which that fact is denoted.

It was thus from the singular circumstance that Wöhler and Liebig were at the outset of their career engaged upon the elucidation of the nature of two bodies of identical composition but of dissimilar origin, dissimilar relations, and very different properties, that they were brought into juxtaposition. They desired to know each other; they met in the house of a mutual friend at Frankfort, and the names of Liebig and Wöhler became henceforth linked together for all time.

The origin of that partnership, so fruitful in consequences for science, may be seen in the following characteristic letter:—

"Freedrick Wöhler to Justus Liebig.

"Saerow, near Potsdam, June 8th, 1829.

"Dear Professor,—The content of your last letter to Poggendorff has been communcated to me by him, and I am glad that it affords me an opportunity of resuming the correspondence which we began last winter. It must surely be some wicked demon that again and again imperceptibly brings us into collision with our work, and tries to make the chemical public believe that we purposely seek as opponents these apples of discord. But I think he is not going to succeed. If you are so minded we might, for the fun of it, undertake some chemical work together, in order that the results might be made known under our joint names. Of course, you would work in Giessen and I in Berlin, after we were agreed upon the plan and had communicated with each other from time to time as to its progress. I leave the choice of subject entirely to you.

"I am very glad that you have also determined the identity of pyruvic and cyanic [cyanuric] acids. L. Gmelin would say: 'God be thanked, there is one acid the less!' . . . . . .

"Yours, Wöhler."

Liebig acceded to the proposition at once, and suggested some problem on the chemical nature of nitrogen; this Wöhler found himself unable to undertake as it involved the use of chlorine, to the action of which he was at all times extremely susceptible. On the other hand, he proposed to Liebig that they should continue in common a research on mellitic acid which he himself had begun. Their joint investigation on this body made its appearance within the following year.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. 16, No. 7.

Formation of Sulphides by Pressure; Considerations on the Chemical Nature of Red Phosphorus and of Amorphous Carbon.—W. Spring.—By subjecting mixtures of the respective substances to a pressure of 6500 atmospheres, the author obtained magnesium, zinc, iron, cadmium, bismuth, lead, silver, copper, tin, and antimony sulphides. With aluminium the result appears doubtful. Sulphur could not be combined in this manner with red phosphorus or with carbon. Hence he concludes that polymerisation checks the chemical affinities of any element. The readiness with which certain bodies enter into combination depends on a certain allotropic condition, which finds its explanation in the mobility of the atoms. The more a body is condensed in the solid state, the more its chemical functions are interfered with. The question arises whether carbon, as met with in organised bodies, does not exist in an allotropic condition, not as yet known. This condition may be characterised by the possession of other properties and the power of forming new kinds of compounds, which find their expression in the vital process. Hence organic carbon is the first stage of degradation of organic chemistry, whilst ordinary carbon is merely the powerless residuum of organic chemistry.

A New Tellurium Oxide.—E. Divers and M. Shimosé.—The new compound may be regarded according to its composition as tellurium monoxide. It is permanent in dry air at the common temperature. Its colour is black, with a brownish reflection. If heated strongly in a vacuum it is resolved into tellurium dioxide and free tellurium. It

is slowly attacked by cold potassa lye, but acids, even when cold and dilute, act on it rapidly.

Tellurium Sulphoxide.—E. Divers and M. Shimosé.—The authors describe two modifications of this compound, a red, and a brown. The former they regard as a tellurium sulphonate, containing tellurium in an instable bivalent condition, whilst the brown is a more permanent compound of the oxides of the two elements, both quadrivalent. The red form is converted into the brown when heated in a vacuum to 90°. The ultimate composition of each form is SO_3Te.

The Occurrence of Free Tartaric Acid in Wine, and its Determination.—A. Claus.—The author proves the existence of free tartaric acid as a normal constituent of wine. He proposes to extract this acid from the residue of evaporation, not with ether, but with absolute alcohol. The wine must have been previously evaporated to dryness, and the residue kept for some time at 110° in the air-bath.

Methylene Blue.—A. Bernthsen.—A preliminary communication. The blue contains to C_{16}, not 4, but 3 atoms of N. By reducing this colouring-matter with sodium hydrosulphite, the author has obtained a leuko base, methylene-white, which is capable of forming methyl and acetyl compounds.

Condensation-products of Œnanthol.—W. H. Perkin.—The author examines the action of nascent hydrogen upon œnanthol in an acid and in an ethereal solution. In the latter case the products are heptylic alcohol and heptylic acid.

Polymerisation of Œnanthol.—W. H. Perkin.—This memoir is given in detail in the *Journal of the Chemical Society*.

Action of the Halogenous Substitutes of the Fatty Acids upon Aniline.—C. A. Bischoff.—If a mixture of 1 mol. aniline and 1 mol. chloracetester is slowly heated in a cohobator to above the boiling-point of aniline hydrochlorate, the crystals of phenyl-glycin-ethyl-ester formed in the cold are first melted; the mass then boils, and on distilling off there passes over first unchanged chloracetester, streams of hydrochloric acid and some water, and aniline hydrochlorate. The remaining reddish oily matter congeals on cooling to a brittle glassy substance, which may be readily powdered, and is then bright yellow and very permanent in the air. The reaction of brom-propionic ester is similar. In that of β-chlor-α-hydroxy-propionic ester the temperature must be regulated in a different manner.

Synthesis of Ketonic Acids of the Aromatic Series and of Polybasic Acids of the Fatty Series.—C. A. Bischoff.—A preliminary communication.

Remark.—C. Böttinger.—The author points out an inaccuracy in J. M. Lovin's paper on certain substitution-products of lactic acid.

Action of Ethyl-dichloramine upon Aromatic Amines and Hydrazo-benzol.—A. Pierson and K. Heumann.—The authors have studied the behaviour of ethyl-dichloramine with para-toluidine, when para-azotoluol is formed along with ethylamine hydrochlorate; also of ethyl-dichloramine with aniline, the results being trichloraniline and dichloraniline; also of ethyl-dichloraniline with hydrazo-benzol, when the products were azobenzol and ethylamine hydrochlorate.

A Simplification of Victor Meyer's Method of Determining Vapour Densities.—H. Schwarz.—This memoir requires the accompanying illustration.

The Action of Dibrom-barbituric Acid upon Sulphourea and the Sulpho-cyanides.—W. Trzcinski.—The behaviour of dibrom-barbituric acid with sulphurea and the sulphocyanides is different from that of the dibrom-pyruvic and dibrom-succinic acids. The bromine is eliminated, and there is substituted for it a molecule of sulphurea or of a metallic sulpho-cyanide.

Dicyan-diamide.—E. Bamberger.—An investigation of the chemical character of this compound, with the view of ascertaining whether it is a guanidine in which 2 atoms of hydrogen are replaced by the bivalent radicle carbimide, or a guanidine in which cyanogen plays the part of an amide hydrogen.

A New Acid in the Juice of Beet-root.—E. O. v. Lippmann.—The new compound, $C_6H_8O_8$, is a powerful tribasic acid, forming soluble salts with the alkalies, and, with baryta, white granules, insoluble in water and alcohol. It has a close resemblance to the oxy-citric acid of Pawolleck.

Certain Fluorene Derivatives.—J. Holm.—The author has obtained dibrom-phenylen-keton by the oxidation of dibrom-fluorene. Dibrom-fluorene-keton is converted by the action of melting potassa into dibrom-phenyl-benzoic acid. The oxidation of tribrom-fluorene yields the same β-dibrom-diphenylen-keton as does bibrom-fluorene. Trichlor-fluorene was obtained by passing chlorine slowly into a solution of fluorene in carbon disulphide.

Chinoline of Coal-tar.—E. Jacobsen and C. L. Reimer.—The chinoline-yellow of the authors is obtained from coal-tar, whilst that of Traub is prepared from cinchonine. Chinoline-yellow, $C_{17}H_9NO_2$, is not a base; it dissolves in strong sulphuric acid, but on the addition of water it is deposited quite free from sulphuric acid.

Air-baths.—Lothar Meyer.—This paper cannot be reproduced without the six accompanying figures.

MISCELLANEOUS.

Royal Institution.—Professor Tyndall will begin a Course of Six Lectures on "The Older Electricity—its Phenomena and Investigators," on Thursday next (Feb 28), illustrated by experiments; and Captain Abney, R.E., will begin a Course of Six Lectures on Photographic Action, considered as the Work of Radiation," on Saturday (March 1). Professor Hughes will give a discourse on Friday evening next on "Theory of Magnetism," illustrated by experiments.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Colours for Leather Staining.—Could any of your numerous readers inform me where I could obtain a good monograph (book) on colours, principally for leather staining? I shall be much obliged for the information.—C. W. S.

MEETINGS FOR THE WEEK

Monday, Feb. 25th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.

Tuesday, 26th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie.
—— Society of Arts, 8. "Reflections on Chinese History, with reference to the Present Situation of Affairs," by Demetrius G. Boulger.

Wednesday, 27th.—Society of Arts, 8. "Internal Corrosion and Scale in Steam-Boilers," by G. Swinburne King.

Thursday, 28th.—Royal, 4.30.
—— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
—— London Institution, 7.
—— Society of Arts, 8. "Recent Progress in Dynamo-Electric Machinery," by Prof. Silvanus P. Thompson.

Friday, 29th.—Royal Institution, 8. "Theory of Magnetism," by Prof. Hughes, at 9.

Saturday, March 1.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1266.

ON THE OCCURRENCE OF PHENOL IN THE STEM, LEAVES, AND CONES OF *PINUS SYLVESTRIS*.

A Discovery Bearing on the Flora of the Carboniferous Epoch and the Formation of Petroleum.

By A. B. GRIFFITHS, Ph.D., F.C.S.,
Membre de la Société Chimique de Paris, Medallist in Chemistry and Botany, &c.

Having found, in small quantities, alcohols of the C_nH_{2n-7} series, last summer, in the stem, acicular leaves, and cones of *Pinus sylvestris*, I wish in this paper to say a few words on the subject.

First of all, I took a number of cones, cut them up into small pieces, and placed them in a large glass beaker, then nearly filled it with distilled water, and heated to about 80° C., keeping the decoction at this temperature for about half an hour, I occasionally stirred with a glass rod, and then allowed it to cool, and filtered. This filtrate was then evaporated nearly to dryness, when a small quantity of six-sided prisms crystallised out, which subsequently were found to be the hydrate of phenol, $(C_6H_5Ho)_2H_2O$. Its melting-point was found to be 17·2° C. Further, the crystals already referred to were dissolved in ether, and then allowed to evaporate, when long colourless needles were obtained, which, on being placed in a dry test-tube and the tube placed in a water-bath kept at 42° C., were found to melt, and on making a careful combustion analysis of these crystals, the following composition was obtained:—

Carbon	76·6
Hydrogen	6·4
Oxygen	17·0
	100·0

This gives C_6H_6O, which is the formula for phenol.

On dissolving some of these crystals in water (excess) and adding ferric chloride, a beautiful violet colour was imparted to the solution. To another aqueous solution of the crystals was added bromine water, and a white precipitate was obtained, consisting of tribromo-phenol. An aqueous solution of the crystals immediately coagulated albumen.

All these reactions show that the phenol occurs in the free state in the cones of this plant. In the same manner I treated the acicular leaves, and portions of the stem separately, both being previously cut up into small pieces, and from both I obtained phenol.

I have ascertained the relative amount of phenol in each part of the plant operated upon: by heating the stem with water at 80° C. and filtering, and repeating this operation until the aqueous filtrate gave no violet colour with ferric chloride and no white precipitate with bromine water.

I found various quantities according to the age of the stem. The older portions yielding as much as 0·1021 per cent, while the young portions gave only 0·0654 per cent. The leaves yielding, according to their age, 0·0936 and 0·0315 per cent; and the cones also gave varying amounts according to their maturity, the amounts varying between 0·0774 and 0·0293.

Two methods were used in the quantitative estimation of the amount of phenol. The first was the new volumetric method of M. Chandelon (*Bulletin de la Société Chimique de Paris*, July 20, 1882; and *Deutsch-Amerikanische Apotheker Zeitung*, vol. iii., No. 12, September 1, 1882), which I have found to be very satisfactory. The process depends on the precipitation of phenol by a dilute aqueous solution of bromine as tribromo-phenol. The second method was to extract, as already stated, a known weight of each part of the plant with water, until the last extract gives *no* violet colour with ferric chloride, and no white precipitate with the bromine test (which is capable of detecting in a solution the 1-60.000th part of phenol). The aqueous extract is at this point evaporated, then ether is added, and finally the ethereal solution is allowed to evaporate. The residue (phenol) is weighed directly, and from this the percentage can be ascertained. By this method of extraction, the oil of turpentine, resins, &c., contained in *Pinus sylvestris* do not pass into solution, because they are insoluble in water, even when boiling; what passes into solution besides phenol is a little tannin, which is practically insoluble in ether.

From this investigation it will be seen that phenol exists in various proportions in the free state in the leaves, stem, and cones of *Pinus sylvestris*, and as this compound is a product in the distillation of coal, and as geologists have to a certain extent direct evidence that the flora of the carboniferous epoch was essentially cryptogamous, the only phænogamous plants which constituted any feature in "the coal forests" being the coniferæ, and as coal is the fossil remains of that gigantic flora which contained phenol, I think my discovery of phenol in the coniferæ of the present day, further supports, from a chemical point of view, the views of geologists that the coniferæ existed so far back in the world's history as the carboniferous age.

I think this discovery also supports the theory that the origin of petroleum in nature is produced by moderate heat on coal or similar matter of a vegetable origin. For we know from the researches of Freund and Pebal (*Ann. Chem. Pharm.*, cxv., 19) that petroleum contains phenol and its homologues, and as I have found this organic compound in the coniferæ of to-day, it is probable that petroleum in certain areas has been produced from the conifers and the flora generally of some primæval forests. It is stated by numerous chemists that "petroleum almost always contains solid paraffin" and similar hydrocarbons. Professors Schorlemmer and Thorpe have found heptane in Pinus, which heptane yielded primary heptyl-alcohol and methyl-pentyl-carbinol, exactly as the heptane obtained from petroleum does (*Annalen de Chemie*, ccxvii., 149, and clxxxviii., 249; and *Berichte der Deutschen Chemischen Gesellschaft*, xiii., 1649); and, further, petroleum contains a large number of hydrocarbons which are found in coal. Again, Mendelejeff, Beilstein, and others (*Bulletin de la Société Chimique de Paris*, No. 1, July 5, 1883), have found hydrocarbons of the—

$$C_nH_{2n+2}, C_nH_{2n-6},$$

also hydrocarbons of the C_nH_{2n} series in the petroleum of Baku, American petroleum containing similar hydrocarbons.

I think all these facts give very great weight to the theory that petroleum is of organic origin.

On the other hand, Berthelot (from his synthetic production of hydrocarbons) believes that the interior of the globe contains alkaline metals in the *free* state, which yield acetylides in the presence of carbonic anhydride, which are decomposed into acetylene by aqueous vapour. But it has been already proved that acetylene may be polymerised, so as to produce aromatic carbides, or the derivatives of marsh-gas, by the absorption of hydrogen. Berthelot's view, therefore, is too imaginative; for the presence of *free* alkaline metals in the earth's interior is an unproved and very improbable hypothesis. Byasson states that petroleum is formed by the action of water, carbonic anhydride, and sulphuretted hydrogen upon incandescent iron. Mendelejeff thinks it is formed by the action of aqueous vapour upon carbides of iron; and in his article, "Petroleum, the Light of the Poor" (in this

month's, February, number of *Good Words*), Sir Lyon Playfair, K.C.B., F.R.S., &c., holds opinions similar to those of Mendelejeff.

Taking in consideration the facts that solid paraffin is found in petroleum and is also found in coal, and from my own work that phenol exists in *Pinus sylvestris*, and has been found by others in coal which is produced from the decomposition of a flora containing numerous gigantic coniferæ allied to Pinus, and that petroleum contains phenol, and each (*i.e.*, petroleum and coal) contains a number of hydrocarbons common to both, I am inclined to think that the balance of evidence is in favour of the hypothesis that petroleum has been produced in nature from a vegetable source in the interior of the globe. Of course, there can be no practical or direct evidence as to the origin of petroleum; therefore "theories are the only lights with which we can penetrate the obscurity of the unknown, and they are to be valued just as far as they illuminate our path."

In conclusion I think that there is a connecting link between the old pine and fir forest of bygone ages and the origin of petroleum in nature.

THE CHEMICAL WORK OF WÖHLER.*

By Professor THORPE, F R.S.

(Concluded from p. 93).

It would be quite impossible within the limits of an hour to attempt to give you anything approaching a complete analysis of Wöhler's work. Wöhler was the author of 275 memoirs and papers, and of these 15 were published in concert with Liebig. I must therefore confine my selection from this vast amount of material to those papers which are of paramount importance from the influence which they have exerted on chemical theory or on the development of the chemical arts.

Very shortly after the publication of the work on mellitic acid, Wöhler proposed to Liebig a joint investigation on cyanuric acid, in the course of which he observed the extraordinary transformation of that acid into cyanic acid, and the re-conversion of the cyanic acid into cyanuric acid—one of the most remarkable instances of molecular rearrangement known to the chemist. The work progressed little for some months, owing to the demands made by *Berzelius's Jahresbericht* on Wöhler's time. "Wirf die Schreiberei zum Teufel," wrote Liebig, "und gehe in das Laboratorium, wohn Du Gehörst."

It was that functionary, doubtless, who in due time carried off the writing to his master the printer. Wöhler went back to his laboratory, and in a few weeks the two investigators had obtained the clue to the puzzle. Liebig wrote to Wöhler—"Now that I have received your experiments the whole thing is cleared up, and with what satisfaction for us! The matter is now decided: the cyanic acid of Serullas is identical with that from urea.....Ich bin ganz nämsch vor Freude, dars unser Kindlein hun fehlerers in die Welt geretzwird, ohne Buckel oder Klumpfuss." [It had been suggested to attack the fulminic acid again.] "The fulminic acid we will allow to remain undisturbed. Like you, I have vowed to have nothing more to do with this stuff. Some time back I wanted, in connection with our work, to decompose some fulminating silver of means by ammonium sulphide: at the moment the first drop fell into the dish the mass exploded under my nose. I was thrown backwards, and was deaf for a fortnight, and became almost blind."

The work on cyanic acid appeared in *Poggendorff's Annalen* during the last month of 1830, and Wöhler was able to send the "Kindlein un Neuem Kleide," as he says, with a new year's greeting to his friend. Liebig had suggested fresh work, but at the moment Wöhler was in no humour to attack anything organic. The Swedish chemist Sefström had just announced the existence of a new element in the slag of certain iron ores, and this very substance had slipped through Wöhler's fingers unperceived. "I was an ass," he wrote to his friend, "not to have detected it two years ago in the lead ore from Zimapan, in Mexico. I was busy with its analysis, and had found something strange in it, when I was laid up for some months in consequence of breathing hydrofluoric acid fumes, and so the matter was allowed to rest. Meanwhile Berzelius sends me word of its discovery by Sefström in Swedish bar iron and in slag. It is very like chromium, and just as remarkable. Moreover, it is the same metal that Del Rio found in the Mexican lead ore and called Erythronium: Descotils, however, had declared this ore to be lead chromate."

Wöhler, no doubt, found a ready sympathiser in Liebig, to whom, not many years before, a similar experience had happened. We all know the story of the young chemist whose unscientific use of the imagination cost him the discovery of the element *bromine*. Wöhler had sent some of the substance to Stockholm, and Berzelius wrote as follows:—

"Stockholm, Jan. 22, 1831.

"As to the small quantity of the body marked (?) I will relate the following story:—'In the far North there lived in the olden time the goddess Vanadis, beautiful and gracious. One day there came a knock at her door. The goddess was in no hurry, and thought, "They can knock again": but there came no further knock, for he who had knocked had passed on. The goddess, wondering who it could be that cared so little to be let in, ran to the window and recognised the departing one. "Ah!" said she to herself, "It is that lazy fellow, Wöhler! He richly deserves his name since he cares so little to come in." Some days after some one else knocked, repeatedly and loud. The goddess opened the door herself: it was Sefström who entered, and as a consequence of their meeting Vanadium came to light.

"Your specimen with the (?) is, in fact, vanadium oxide. But he that has found the mode of artificially forming an organic body can well renounce the discovery of a new metal; indeed, one might have discovered ten unknown elements without as much skill as attaches to the masterly work which you and Liebig have carried out together, and first communicated to the scientific world."

In 1831 Wöhler was called from Berlin to Cassel, and for some little time he was wholly engaged in the planning and erection of his new laboratory at the Gewerbe School in that town. In the spring of the following year he was again ready for a new research, and this time it was to be the finest piece of work that the two investigators jointly engaged in. It was, in fact, to be the classical research on Bitter Almond Oil. On the 16th of May, 1832, Wöhler wrote to Liebig:—"Ich sehne mich nach einer ernsten Arbeit, sollten wir nicht die Confusion mit dern Bittermandelöl ins Reine bringen? Aber woher Material?"

It must have been a *forscherblick* amounting to inspiration which led Wöhler to take up this subject. But neither he nor Liebig could have been wholly conscious of the consequences which were to follow up their work. To-day, oil of bitter almonds is made artificially in Germany by the hundredweight. At that time the investigators could only obtain it in small quantities from Paris; they had, indeed, to thank Pelouze for the material with which they worked. Wöhler made this, his greatest research, under the cloud of a great sorrow: after barely two years of married life he lost his wife. Liebig, in the tenderest manner, brought him over to Geissen, and sought to wean him from his grief and the sense of his loneliness by his company and the wholesome distraction of their joint work made side by side.

On the 30th of August, 1832, Wöhler wrote to Liebig from Cassel:—"I am here back again in my darkened

* A Lecture delivered in the Royal Institution on Friday evening, Feb 15th.

solitude. I do not know how I shall thank you for the affection with which you received me and kept me by you so long. How happy was I that we could work together face to face.

"I send you with this the memoir on bitter almond oil. The writing has taken me longer than I anticipated. I want you to read through the whole with the greatest care, and to notice particularly the numbers and formulæ. What does not please you alter at once. I have often felt that there was something not quite right, without being able to find what was right."

I shall not attempt to dwell upon the outcome of this great work. The investigation on the radicle of benzoic acid will ever remain one of the greatest achievements in the history of organic chemistry. The work was, indeed, epoch-making in the far-reaching nature of its consequences. It was full of facts and rich in the promise of new material: a veritable mine from which subsequent workers like Cannizzaro, Fehling, Piria, Stas, and Hlasiwetz have dug rich treasure. The immediate effect of the paper was to establish the doctrine of organic radicles by demonstrating the existence of groups of bodies which had their analogues and prototypes in inorganic chemistry. The concluding words of the memoir strike, in fact, the keynote of the whole investigation. "In once more reviewing and connecting together the relations described in this memoir," wrote Liebig and Wöhler, "we find that they may be grouped round a common nucleus, which preserves intact its nature and composition in its association with other bodies. This stability has induced us to regard this nucleus as a kind of compound element, and to propose for it the special name of Benzoyl."

Another significant feature in the memoir was that each of the substances described and correlated was the type of a distinct group of bodies, some of which were known, but of which the analogies and relations were unthought of. Others of these bodies were yet to be discovered—a matter of little difficulty when the modes of their origin had been indicated.

The effect of this memoir on the chemical world was instantaneous. Berzelius was delighted. "The fact put forward by you," he wrote to Wöhler and Liebig, "give rise to such considerations that they may well be regarded as the dawn of a new day in chemistry. On this account I would propose that this first-discovered radicle, composed of more than two elements, should be named *proin* (from πρωϊ, the beginning of day), or orthrin (from ὄρθρος, daybreak); terms from which names like *proic acid*, *orthric acid*, *proic chloride*, *orthric chloride*, &c., could be readily derived." Berzelius further proposed to indicate the idea of the nucleus which was thus seen to function in these bodies by giving to benzoyl the symbol Bz.

Wöhler remained in Cassel for nearly five years. In the autumn of 1835 died Stromeyer, Professor of Chemistry in the University of Gottingen. Opinions were divided as to his successor: the choice lay between Liebig and Wöhler. Eventually Wöhler was selected, and entered on his work at Gottingen in the early part of 1836. He was succeeded at Cassel by Bunsen, who was at that time *privat docent* in Gottingen. In the October of the year Wöhler was again ready for fresh work. He writes to Liebig:—"I am like a hen which has laid an egg, and straightway sets up a great cackling. I have this morning found how oil of bitter almonds containing prussic acid may be obtained from amygdalin, and would propose that we jointly undertake the further investigation of the matter, as it is intimately related to the benzoyl research, and it would seem strange if either of us should work alone again in this field. Dem estässt sich gar nicht abschen wie weit es sich Erstreckt, und ich glaube es ist geuris fruehlbar, wenn es mit Deinem Mist gellüngst wird."

In a couple of days afterwards Wöhler was ready with the fundamental facts for the research, and had sketched out its plan. He writes:—"I have just made a most remarkable discovery in relation to the amygdalin. Since it appeared that bitter almond oil might be obtained from amygdalin it occurred to me that the one might be converted into the other by simply distilling almonds with water, by an action similar to that of a ferment upon sugar, the change in this case being due in all probability to the albumin in the almonds. And this idea seems to be completely established. The facts are as follows:—

"1. Amygdalin, dissolved in water and digested with a bruised sweet almond, begins almost immediately to smell of bitter almond oil, which after a time may be distilled off in such quantity that it would appear that the amygdalin was wholly transformed into it.

"2. A filtered emulsion of sweet almonds produces the same effect.

"3. A boiled emulsion of sweet almonds, in which, therefore, the albumin is coagulated, affords not the smallest trace of oil with amygdalin.

"4. Bruised sweet almonds, covered with alcohol, and freed therefrom by pressure, transform, as before, amygdalin into bitter almond oil.

"5. Bruised peas, or the albumin they contain, give no oil with amygdalin.

"There are three points therefore to be ascertained:—

(*a*) What is the substance in bitter or sweet almonds which in contact with amygdalin and water forms bitter almond oil?

(*b*) Is the action by double decomposition or catalytic, like that of a ferment?

(*c*) What is the other product which in all probability is formed in addition to the oil and prussic acid?"

The merest tyro in organic chemistry to-day is familiar wiih the broad features of this investigation, and knows the answers which Liebig was able to give to his friend's interrogatives. The third substance Liebig discovered to be sugar. Under the influence of a nitrogenised ferment, termed by Liebig and Wöhler *emulsin*, amygdalin in presence of water is decomposed into benzaldehyd (bitter almond oil), prussic acid, and sugar (glucose), thus:—

$$\underbrace{C_{20}H_{27}NO_{11}}_{\text{Amygdalin.}} + \underbrace{2H_2O}_{\text{Water.}} = \underbrace{C_7H_6O}_{\text{Benzaldehyd.}} + \underbrace{CNH}_{\text{Prussic Acid.}} + \underbrace{2C_6H_{12}O_6}_{\text{Glucose.}}$$

It simply remains to explain why this reaction only occurs when the almonds are bruised and digested with water. Both the emulsin and the amygdalin exist together in the almonds, but are contained in separate cells, and are only brought into oontact by the rupture of the cell-walls and the solvent action of the water. Amygdalin was the prototype of a large and important group of substances classed together as the glucosides.

At the instigation of Wöhler, the friends again returned to the question of the chemical nature of uric acid, and the memoir which they eventually published on the subject is of the profoundest interest not only to the chemist but also to the physiologist. Uric acid, originally discovered by the illustrious Scheele, was shown in 1815, by William Prout, then a boy of 19, to be the main constituent of the solid excreta of reptiles. Other chemists had succeeded in obtaining various derivatives from it; indeed Prout himself had prepared from it the so-called purpuric acid or murexide—a substance which years after obtained a transitory importance in the arts as a colouring-matter. But nothing was known concerning the constitution of the body, or of its relations to its derivatives, until Wöhler and Liebig attacked the problem. The extraordinary mutability of uric acid, which had baffled and deceived previous investigators, was to Wöhler and Liebig the very clue to the labyrinth leading to a veritable treasure house, and the wonderful insight and rare analytical skill of these two great men were never more clearly indicated than in the way in which they trod this intricate maize. No fewer than fifteen new bodies were added to the list of chemical compounds, and these were correlated with the same masterly lucidity that was so strikingly exhibited

in the memoir on the radicle of benzoic acid. Some of the greatest triumphs of modern chemistry are seen in the synthesis of organic bodies; that organic chemistry was about to advance along this line was clearly foreseen by Wöhler and Liebig. In opening their account of this the last great work they did in common, they say:—"From this research the philosophy of chemistry will draw the conclusion that the ultimate synthetical formation of all organic bodies, in so far as they are not organised (in so weit sie nicht mehr dem organismus angehören), may be regarded as not only probable but as certain. Sugar, salicin, morphin will be artificially obtained. As yet we know nothing of the way by which this result is to be attained, inasmuch as the proximate materials for forming these bodies are unknown; but we shall come to know them."

Henceforth the friends worked but little in common. Liebig's energies were spent in other directions, and Wöhler turned his attention to inorganic chemistry. Time allows only the very briefest mention to be made of his more important discoveries in this department of the science. We have first his isolation of boron and the preparation of the compounds of boron with aluminium and nitrogen, work done in concert with his friend, Sainte-Claire Deville. The readiness with which boron unites with nitrogen, and the mode in which the compound may be decomposed, led Wöhler to a conception of the origin of boric acid and borax in the volcanic waters in which they are frequently found. In collaboration with Buff he discovered the spontaneously inflammable hydride of silicon, the analogue of marsh-gas the simplest of the hydrides of carbon, and thereby laid the foundation-stone of a superstructure which in time to come may only be less imposing than that built up of the compounds of carbon.

Many years ago Wollaston noted the presence of beautiful lustrous copper-coloured cubes in the slags from the iron blast-furnaces, which he assumed to be metallic titanium. Wöhler proved this substance to be a compound of carbon, nitrogen, and titanium, and showed how it might be obtained. Of all the elements known to the chemist up to the period of Wöhler's cessation from work it may be safely averred that there was not one but that had passed through his hands in some form or other. Now he was busy with chromium, then with cerium, next with uranium and the platinum metals; titanium, tantalum, thorium, thallium, tungsten,—all came in for some share of his attention, Of the minerals and meteorites he analysed the number is legion. Indeed, as Professor Hofmann says, whoever sent him a piece of meteoric iron gained his heart. His restless activity was a source of continual wonder to his friends. "How happy art thou in thy work!" wrote Liebig on one occasion. "Thou art like the man in the Indian fable, who, when he laughed, dropped roses from his mouth!"

The names of Liebig and Wöhler are now so closely intertwined in the history of chemistry that it is hardly possible to avoid comparing the men. Such a comparison has already been drawn by one who of all others is most fitted to draw it. "Liebig," says Dr. Hofmann, "fiery and impetuous, seizing a new thought with enthusiasm, and giving to it the reins of his fancy, tenacious of his convictions, but open to the recognition of error, sincerely grateful, indeed, when made conscious of it. Wöhler, calm and deliberate, entering upon a fresh problem after full reflection, guarding himself against each rash conclusion, and only after the most rigorous testing, by which every chance of error seemed to be excluded, giving expression to his opinion—but both following the path of enquiry in their several ways, and animated by the same intense love of truth! Liebig, irritable and quick to take offence, hot tempered, hardly master of his emotions, which not unfrequently found vent in bitter words, involving him in long and painful quarrels:—Wöhler, unimpassioned, meeting even the most malignant provocations with an immovable equanimity, disarming the bitterest opponent by the sobriety of his speech—a firm enemy to strife and contention—and yet both men penetrated by the same unswerving sense of rectitude! Can we marvel that between two such natures, so differently ordered and yet so complementary, there should ripen a friendship which both should reckon as the greatest gain of their lives?"

Who can fully gauge the influence of such a nature as Wöhler's? How it was exerted on Liebig is indicated in the following letter:—

"Gottingen, March 9, 1843.

"To make war against Marchand, or indeed against anybody else, brings no contentment with it, and is of little use to science. . . . . Imagine that it is the year 1900, when we are both dissolved into carbonic acid, water, and ammonia, and our ashes, it may be, are part of the bones of some dog which has despoiled our graves,—who cares then whether we have lived in peace or anger; who thinks then of thy polemics, of the sacrifice of thy health and rest for science? Nobody. But thy good ideas, the new facts which thou hast discovered,—these, sifted from all that is immaterial, will be known and remembered to all time. But how comes it that I should advise the lion to eat sugar!"

It was thus in philosophic contentment, happy in his work, happy in his home-life, happy in his friendships, that Wöhler lived out his four-score years and two. He made Göttingen famous as a school of chemistry: at the time of the one-and-twentieth year of his connection with the University it was found that upwards of 8000 students had listened to his lectures or worked in his laboratory.

He was a man whom the world has delighted to honour, and there was hardly an academy of science or a learned society which has not in some way or other recognised his services to science. Hs was made a Foreign Member of the Royal Society in 1854, a Corresponding Member of the Berlin Academy in 1855, Foreign Associate of the Institute of France in 1864, and in 1872 he received the Copley Medal from the Royal Society. On the 23rd of September, 1882,—

> He gave his honours to the world again
> His blessed part to Heaven, and slept in peace

A NEW METHOD FOR THE QUALITATIVE SEPARATION OF TIN, ANTIMONY, AND ARSENIC.

By EMIL BERGLUND.

THE author remarks that the present methods for the separation of these metals are either inaccurate or tedious. He proposes a process based on the fact that the sulphides of the three metals when boiled with copper oxide in an alkaline solution are desulphurised and converted into oxygen compounds. The three elements are brought to their highest stage of oxidation, being transformed respectively into stannic, antimonic, and arsenic acids, whilst the copper forms not cuprous but cupric sulphide.

Copper oxide acts with especial ease upon the dissolved sulphur compounds, the denser varieties more slowly than the less compact, but as the latter give a very voluminous precipitate, the author prefers the former. He precipitates a solution of copper with sodium carbonate, and dries the oxide at 100° to 150°. By preference, however, he prepares his oxide from the nitrate as follows:—The solution of copper nitrate is evaporated to dryness in a small porcelain capsule, and heated to incipient decomposition. The mass is let cool, pulverised, and transferred to a porcelain capsule as small as possible, supported on a wire gauze, and heated, with constant stirring, until all the nitrate is decomposed. The heat must not be stronger

than is absolutely necessary. The oxide thus obtained is reduced to an impalpable powder.

This copper oxide is readily sulphurised, and yields a very dense precipitate, easy to filter. The sulphides of tin, antimony, and arsenic must be dissolved in sodium sulphide, not in the hydrate.

The procedure is as follows:—The sulphides, dissolved in the ordinary manner in ammonia, and precipitated by hydrochloric acid, are well washed, and rinsed from the filter into a porcelain capsule. The mixture is raised to a boil; sodium sulphide (avoiding large excess) is added cautiously, stirring constantly, and keeping up a gentle boil until a perfectly clear solution is obtained, or the analyst is convinced that any dark brown residue is merely copper sulphide which has been dissolved by the ammonium sulphide from the original precipitate given by sulphuretted hydrogen. Disregarding this copper sulphide, if present, copper oxide is added, and the stirring and ebullition are continued. It is easy to decide when the desulphurisation is complete; the copper oxide subsides as a very heavy powder, and the supernatant liquid becomes quite colourless, not yellow as previously. If this change does not occur in the course of two or three minutes, more copper oxide must be added, though it is preferable to take a sufficiency at first.

The liquid is filtered while still warm. In the filtrate tin, antimony, and arsenic exist as sodium stannate, antimoniate, and arseniate. If the proportion of antimony is considerable there is formed a white granular precipitate as the filtrate cools. When cold the filtrate is mixed with from a quarter to one-third its volume of alcohol, when the antimony separates out as an exceedingly fine white precipitate, and after standing for some time it is filtered off; if the filtrate is turbid, as is generally the case, it is repeatedly poured back upon the filter. The filtrate, when clear, is boiled to expel the alcohol, and mixed with an excess of ammonium chloride, which is added in a strong solution to prevent unnecessary dilution.

If a milky precipitate is formed on adding the sal-ammoniac, tin is present in the solution; but if no precipitate is formed, this metal exists in mere traces. If arsenic is present, it enters partially or entirely into the precipitate in the form of $2SnO_2As_2O_5$. Whether the sal-ammoniac produces a precipitate or not a few drops of ammonia is added, and a current of sulphuretted hydrogen is passed in. If no precipitate appears very little sulphuretted hydrogen is applied; otherwise this treatment is continued until the precipitate re-dissolves, leaving, possibly, some translucent flakes of silica and alumina. To the liquid, filtered if necessary, is added one-third of its volume of ammonia, and then magnesia mixture, when arsenic is deposited as a crystalline precipitate of ammonio-magnesium arseniate. If the presence of tin has not been distinctly proved, the arsenical precipitate is filtered off after the lapse of an hour, and the filtrate acidulated with hydrochloric acid. A yellow precipitate shows the presence of tin; in its absence there appears merely a slight white deposit of sulphur.

The above method for separating tin and arsenic is a modification of that of Lenssen. The authors purpose studying the applicability of his process to quantitative separations of the three metals.—*Berichte Deutsch. Chem. Gesellschaft.*

The Ptomaines: Chemical, Physiological, and Medico-Legal Investigations.—J. Guareschi and A. Mosso.—The authors examine the influence of the ptomaine hydrochlorate upon nerves and muscles by means of the graphic method. They next inquire into the mechanism of the action of curare, of the ptomaines, and of those poisons which act upon the nervous system. Further experiments were made on the extraction of alkaloids from brain, from the flesh of a calf with and without the use of acids. The method of Dragendorff is found unsatisfactory, and preference is given to that of Stas and Otto.—*Journ. fur Prakt. Chem.*, xxviii., 11.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

TUNGSTEN.

The atomic weight of tungsten has been determined from analyses of the trioxide, the hexchloride, and the tungstates of iron, silver, and barium.

The composition of the trioxide has been the subject of many investigations. Malaguti† reduced this substance to the blue oxide, and from the difference between the weights of the two compounds obtained a result now known to be considerably too high. In general, however, the method of investigation has been to reduce WO_3 to W in a stream of hydrogen at a white heat, and afterwards to reoxidise the metal, thus getting from one sample of material two results for the percentage of tungsten. This method is unquestionably accurate, provided that the trioxide used be pure.

The first experiments which we need consider are, as usual, those of Berzelius.‡ 899 parts WO_3 gave, on reduction, 716 of metal. 676 of metal, reoxidised, gave 846 WO_3. Hence these percentages of W in WO_3:—

79·644 by reduction.
79·905 by oxidation.

Mean 79·7745 ± 0·0880

These figures are far too high, the error being undoubtedly due to the presence of alkaline impurity in the trioxide employed.

Next in order of time comes the work of Schneider,‖ who, with characteristic carefulness, took every precaution to get pure material. His percentages of tungsten are as follows:—

Reduction Series.

79·336
79·254
79·312
79·326
79·350

Mean 79·3156 ± 0·0112

Oxidation Series.

79·329
79·324
79·328

Mean 79·327 ± 0·0010

Closely agreeing with these figures are those of Marchand,§ published in the following year:—

Reduction Series.

79·307
79·302

Mean 72·3045 ± 0·0017

Oxidation Series.

79·321
79·352

Mean 79·3365 ± 0·0105

The figures obtained by v. Borch¶ agree in mean tolerably well with the foregoing. They are as follows:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Journ. f. Prakt. Chem*, 8, 179. 1836.
‡ *Poggend. Annal.*, 8, 1. 1826.
‖ *Journ. f. Prakt. Chem.*, 50, 152. 1850.
§ *Ann. Chem. Pharm.*, 77, 261. 1851.
¶ *Journ. f. Prakt. Chem.*, 54, 254. 1851.

Reduction Series.

79·310
79·212
79·289
79·313
79·225
79·290
79·302

Mean 79·277 ± 0·0106

Oxidation Series.

79·359
79·339

Mean 79·349 ± 0·0067

Dumas* gives only a reduction series, based upon trioxide obtained by the ignition of a pure ammonium tungsten. The reduction was effected in a porcelain boat, platinum being objectionable on account of the tendency of tungstate to alloy with it. Dumas publishes only weighings, from which I have calculated the percentages:—

2·784 grms.	WO_3 gave	2·208 grms.	W.	79·310 per cent.
2·994	,,	2·373	,,	79·259 ,,
4·600	,,	3·649	,,	79·326 ,,
0·985	,,	0·781	,,	79·289 ,,
0·917	,,	0·727	,,	79·280 ,,
0·917	,,	0·728	,,	79·389 ,,
1·717	,,	1·362	,,	79·324 ,,
2·988	,,	2·370	,,	79·317 ,,

Mean 79·312 ± 0·009

The data furnished by Bernoulli† differ widely from those just given. This chemist undoubtedly worked with impure material, the trioxide having a greenish tinge. Hence the results are too high. These are the percentages of W:—

Reduction Series.

79·556
79·526
79·553
79·558
79·549
78·736

Mean 79·413 ± 0·091

Oxidation Series.

79·558
79·656
79·555
79·554

Mean 79·581 ± 0·017

Two reduction experiments by Persoz‡ give the following results:—

1·7999 grms.	WO_3 gave	1·4274 grms.	W.	79·304 per cent.
2·249	,,	1·784	,,	79·324 ,,

Mean 79·314 ± 0·007

Finally we have the work done by Roscoe.‖ This chemist used a porcelain boat and tube, and made six weighings after successive reductions and oxidations, with the same sample of 7·884 grms. of trioxide. These weighings give me the following five percentages, which, for the sake of uniformity with foregoing series, I have classified under the usual separate headings:—

Reduction Series.

79·196
79·285
79·308

Mean 79·263 ± 0·023

Oxidation Series.

79·230
79·299

Mean 79·2645 ± 0·0233

There are still other experiments by Riche*, which I have not been able to get in detail. They cannot be of any value, however, for they give to tungsten an atomic weight of about ten units too low. We may therefore neglect this series, and go on to combine the others:—

Berzelius	79·7745	± 0·088
Schneider, Reduction	79·3156	0·0112
,, Oxidation	79·327	0·0010
Marchand, Reduction	79·3045	0·0017
,, Oxidation	79·3365	0·0105
v. Borch, Reduction	79·277	0·0106
,, Oxidation	79·349	0·0067
Dumas	79·312	0·009
Bernoulli, Reduction	79·413	0·091
,, Oxidation	79·581	0·017
Persoz	79·314	0·007
Roscoe, Reduction	79·263	0·023
,, Oxidation	79·2645	0·0233
General Mean ..	79·3215	0·00085

The rejection of the figures given by Berzelius and by Bernoulli exerts an important influence upon the final result. There is, therefore, no practical objection to retaining them in the discussion.

In 1861 Scheibler† deduced the atomic weight of tungsten from analyses of barium metatungstate, $BaO.4WO_3.9H_2O$. In four experiments he estimated the barium as sulphate, getting closely concordant results, which were, however, very far too low. These, therefore, are rejected. But from the percentage of water in the salt a very good result was attained. The percentages of water are as follows:—

13·053
13·054
13·045
13·010
13·022

Mean 13·0368 ± 0·0060

The work of Zettnow,‡ published in 1867, was somewhat more complicated than any of the foregoing researches. He prepared the pure tungstates of silver and of iron, and from their composition determined the atomic weight of tungsten.

In the case of the iron salt the method of working was this:—The pure, artificial $FeWO_4$ was fused with sodium carbonate, the resulting sodium tungstate was extracted by water, and the thoroughly washed, residual ferric oxide was dissolved in hydrochloric acid. This solution was then reduced by zinc, and titrated for iron with potassium permanganate. Corrections were applied for the drop in excess of permanganate needed to produce distinct reddening, and for the iron contained in the zinc. 11·956 grms. of the latter metal contained iron corresponding to 0·6 cc. of the standard solution. The permanganate was standardised by comparison with pure ammonium-ferrous sulphate, $Am_2Fe(SO_4)_2.6H_2O$, so that, in point of fact, Zettnow establishes directly only the ratio between that salt

* *Ann. Chem. Pharm.*, 113, 23. 1860.
† *Poggend. Annal.*, 111, 573. 1860.
‡ *Zeit. Anal. Chem.*, 3, 260. 1864.
‖ *Ann. Chem. Pharm.*, 162, 368. 1872

* *Journ. f. Prakt. Chem.*, 69, 10. 1857.
† *Ibid*, 83, 324.
‡ *Poggend. Annal.*, 130, 30.

and the ferrous tungstate. From Zettnow's four experiments in standardising I find that 1 c.c. of his solution corresponds to 0·0365457 grms. of the double sulphate, with a probable error of ± 0·0000012.

Three sets of titrations were made. In the first a quantity of ferrous tungstate was treated according to the process given above; the iron solution was diluted to 500 c.c., and four titrations made upon 100 c.c. at a time. The second set was like the first, except that three titrations were made with 100 c.c. each, and a fourth upon 150 c.c. In the third set the iron solution was diluted to 300 c.c., and only two titrations upon 100 c.c. each were made. In sets one and two 30 grms. of zinc were used for the reduction of each, while in number three but 20 grms. were taken. Zettnow's figures, as given by him, are quite complicated; therefore I have reduced them to a common standard. After applying all corrections the following quantities of tungstate in grms. correspond to 1 c.c. of permanganate solution:—

0·028301	First set.
0·028291	
0·028311	
0·028301	
0·028367	Second set.
0·028368	
0·028367	
0·028367	
0·028438	Third set.
0·028438	

Mean 0·0283549 ± 0·0000115

With the silver tungstate, Ag_2WO_4, Zettnow employed two methods. In two experiments the substance was decomposed by nitric acid, and the silver thus taken into solution was titrated with standard sodium chloride. In three others the tungstate was treated directly with common salt, and the residual silver chloride collected and weighed. Here again, on account of some complexity in Zettnow's figures, I am compelled to reduce his data to a common standard. To 100 parts of AgCl the following quantities of Ag_2WO_4 correspond:—

By First Method.

161·665
161·603

Mean 161·634 ± 0·021

By Second Method.

161·687
161·651
161·613

Mean 161·650 ± 0·014

General mean from both series 161·645 ± 0·012

Finally, we have two analyses by Roscoe of tungsten hexchloride, published in the same paper with his results upon the trioxide. In one experiment the chlorine was determined as AgCl; in the other the chloride was reduced by hydrogen, and the residual tungsten estimated. By bringing both results into one form of expression we have for the percentage of chlorine in WCl_6:*—

53·588
53·632
53·610

Mean 53·610 ± 0·015

We have now five ratios from which to calculate the atomic weight of tungsten:—

(1.) Percentage of W in WO_3, 79·3215 ± 0·00085
(2.) Percentage of H_2O in $BaO.4WO_3.9H_2O$, 13·0368 ± 0·0060
(3.) $Am_2Fe(SO_4)_2.6H_2O$: $FeWO_4$ :: 0·0365457 ± 0·0000012 : 0·0283549 ± 0·0000115
(4.) AgCl : Ag_2WO_4 :: 100 : 161·645 ± 0·012
(5.) Percentage of Cl in WCl_6 53·610 ± 0·015

From these we get five values for tungsten, as follows:—

From (1)	W = 183·703	± 0·041
,, (2)	,, 183·532	0·156
,, (3)	,, 183·923	0·120
,, (4)	,, 183·248	0·069
,, (5)	,, 183·639	0·109
General mean	,, 183·610	0·032
Or, if O = 16, then	,, 184·032	

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 21, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—H. Cave, F. W. Fleming, E. E. Graves, A. E. Lewis, S. Smith.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Drs. Wright and Hodgkinson, duly elected Fellows:—L. Archbutt, J. H. Burland, D. Bain, W. H. Barr, R. A. Bush, P. S. Chantrell, A. F. Damon, H. C. Draper, T. R. Duggan, V. Edwards, W. T. H. Elsley, G. W. Gibson, F. W. Harris, T. Hilditch, R. E. Moyle, P. Morton, W. J. Orsman, F. R. Power, A. E. Simpson, C. W. Sutton, H. G. Shaw, E. F. Smith, F. W. Tompson, A. Tarn, E. W. Voelcker.

It was announced that the following changes in the Vice-Presidents and Council were proposed:—Vice-Presidents—Dr. T. E. Thorpe and W. Weldon nominated instead of Dr. Crum Brown and Prof. Emerson Reynolds, who retire. Council—Drs. Carnelly and Messel, R. J. Friswell, and M. Carteighe nominated in place of Capt. Abney, Dr. Mills, Prof. McLeod, and G. H. Makins. Dr. Hodgkinson, Dr. Thorne, and F. W. Toms were appointed auditors.

The following paper was then read by Dr. Gilbert:—"*On the Composition of the Ash of Wheat Grain and Straw Grown at Rothamsted in Different Seasons and by Different Manures*," by Sir J. P. Lawes and Dr. J. H. Gilbert. This paper gives an account, including duplicates, of 253 analyses, most of which were made by R. Richter of Berlin. The ashes were prepared at Rothamsted, being burnt in oblong platinum dishes by surface heat, in order to prevent, as far as possible, any fusion. Every ash is of produce of known history of growth, as to soil, season, and manuring. The experiments are arranged in three series. The first illustrates the influence of fluctuation of season from year to year under three known but very different conditions as to manuring, during sixteen consecutive seasons. The second shows the influence of four characteristic seasons—two favourable and two unfavourable—under nine different conditions as to manuring. The third demonstrates the influence of continuous exhaustion or supply of certain constituents, as it represents the proportionally mixed produce for the ten years 1852-61, and the ten years 1862-71, from ten differently manured plots. In the first series the three plots were respectively (1) unmanured, (2) treated with 14 tons farmyard manure per acre, and (3) treated with

* The actual figures are as follows:—
19·5700 grms. WCl_6 gave 42·4127 grms. AgCl.
10·4326 ,, 4·8374 ,, tungsten.

about 200 lbs. ammonium sulphate and 200 lbs. of ammonium chloride per acre annually. The principal points of interest in the analyses are the relative quantities of potash and phosphoric acid. The chief conclusions are that with normal maturation the grain is of nearly uniform composition whatever the manure, that the deviations from normal mineral composition are associated with deviations from normal development of the organic substance, and that the season has much more influence on the mineral composition of the grain than the manure. An obvious difference can nevertheless be detected in the average composition of the grain under the different conditions as to manuring: thus, the grain grown by ammonium salts alone shows exhaustion of potash, and especially of phosphoric acid. In the second series of analyses the following four seasons were selected:—1852, bad both as to quantity and quality of produce; 1856, quantity fair but quality indifferent; 1858, quantity moderate, quality above the average; 1863, good as to quantity and quality. As to manuring, the conditions were:—Unmanured; farmyard manure; ammonium salts alone; ammonium salts and superphosphate; ammonium salts, superphosphate, and potash salt; ammonium salts, superphosphate, and magnesia salt; and finally a mixture of the last three. In the third series of analyses the manures employed were almost the same as those used in the second series, but the analyses relate to a period of twenty consecutive years. The results confirm those obtained in Series 1 and 2. It is seen that the amounts of mineral constituents taken up by the plant over a given area, depend very directly on the amounts in available condition within the soil, and that while the quantity stored in the grain is nearly uniform, the amounts remaining in the straw have a very obvious connection with the supply or exhaustion in the soil. The influence of season is also well marked. The composition of the grain, as to its mineral constituents, seems only to vary with the manure when there is a very abnormal deficiency of one or more constituents, having regard to the amount of growth which is induced by the liberal supply of others. The paper is very lengthy (over 70 pages), and contains eighteen tables of analyses. The authors promise in a future communication to give a similar series of analyses of ashes from barley, leguminous crops, root crops, potatoes, and the mixed herbage from grass land.

The President complimented Dr. Gilbert on the lucidity with which he had communicated the paper. It seemed to him a most interesting fact, brought out by this remarkable series of ash determinations, that the composition of the grain should be so uniform.

Mr. J. Farrington gave an instance of the importance of the season with reference to the action of manures with potatoes. In a wet season the addition of kainit was without beneficial influence on the crop, but in a dry season its use was found to be very beneficial. He had also noticed that nitrates had at first more effect than ammonium salts in promoting growth.

Mr. Lloyd was much impressed with the fact that the mineral constituents in a poor crop were relatively larger than in a good crop. The roots probably gathered the mineral constituents independently of the season, and so if the weather was bad, and the organic constituents were not formed, the amount of mineral matter would be apparently increased. As the straw seemed to vary more or less with the manure applied, an analysis of the straw-ash might perhaps serve as an index of the mineral constituents wanting in the soil.

Dr. Gilbert said that at present it would be difficult to differentiate the mineral constituents of the straw-ash. There was no doubt that in bad seasons the maturation of the grain was sluggish and the starch formation imperfect, and so the percentage of mineral matter was raised.

"*On the Analysis of Shotley Bridge Spa Water*," by H. Peile. Apparently only one analysis, and that incorrect, has been made of this water. The author has obtained the following numbers, indicating grammes per litre:—Barium chloride, 0·0569; ammonium chloride, 0·0042; calcium chloride, 0·2632; magnesium chloride, 0·0437; lithium chloride, 0·0565; potassium chloride, 0·0513; sodium chloride, 1·7333; calcium bicarbonate, 0·3964; ferrous bicarbonate, 0·0155; magnesium bromide, 0·0075; traces of magnesium bicarbonate and iodide, maganous bicarbonate, silica, phosphates, albumenoid ammonia. The water tastes strongly of iron.

The Society then adjourned to March 6th, when a paper by Drs. Armstrong and Miller, "On the Hydrolysis of Sulpho-Compounds," will be read.

NOTICES OF BOOKS.

The Art of Soap-Making. A Practical Handbook of the Manufacture of Hard and Soft Soaps, Toilet Soaps, &c. By Alexander Watt. London: Crosby Lockwood and Co.

Even in these days of technological education a special treatise on soap-making has, prior to the issue of this work, been a desideratum in English literature. Dissertations on the subject have appeared from time to time in technical cyclopædias—we may mention those of Dr. Ure and of Messrs. Spon—and a variety of information may be found scattered through the scientific journals. But, with the exception of Morfit's important work, a special handbook of soap-making has been wanting. This has been a misfortune; not a few persons, well acquainted with the practice of the art, have remained unacquainted with its underlying principles, and have consequently been careless of, or even hostile to, improvement.

The work before us opens with a historical introduction, from which we learn some humiliating facts. Speaking of the introduction of a process for bleaching palm-oil the author says:—"When at last the trade were induced to give the process a trial, not unfrequently would the workmen put raw (that is unbleached) palm-oil into the batch which had been operated upon during the patentee's absence, so that their employers might denounce the demonstration as a failure." No improved patent-law can secure rapid industrial progress where employers and employed seem so obstinately averse to improvement.

We come next to the theory of saponification as based upon the researches of Chevreul and of Liebig.

In the second chapter we find a description of the plant of a soap-factory, the coppers, ley-tanks, frames, crutching tools, barring-apparatus, &c.

The materials used in soap-making are next considered. Here cotton-seed oil, an article coming more and more into use, is merely named, without any account of its properties.

Under "caustic soda" we read that the author, in conjunction with Mr. J. B. Spence, has devised and patented a process for obtaining caustic soda by the electrolysis of common salt. He hopes by this means to produce it at a great reduction in comparison with present prices. We need scarcely say that if no drawback turns up this will be a most important step. No mention is made of the fact that caustic potash is now made on the large scale in the solid state, so that the soap-boiler has now no occasion to be at the trouble of causticising common potash or pearl-ash.

The chapter on preparing the leys has lost much of its interest since caustic alkali became a common article of sale.

The manufacture of hard soaps is described very fully, in part according to Dussauce. In the instructions for making French mottled soaps taken from the latter author the alkali is directed to be obtained by causticising black-ash, which is also used in the London mottled soaps.

The old process of making hard soaps by saponification

with potash and subsequent conversion into a soda-soap, is described as being abandoned in England. It was an exceedingly wasteful procedure.

Resin soaps are next described as made in France. It is recommended to saponify the fatty matter and the resin separately, and to incorporate the two soaps by subsequent boiling. After treating of cocoa-nut oil, which requires a peculiar treatment, and gives, when used alone, a badly smelling soap, the author goes on to the "cold process," first devised by Mr. W. Hawes. The chief obstacle to the common adoption of this process has been the difficulty of obtaining ley of a sufficient strength, *i.e.*, 36° B., without previous evaporation. Now caustic soda is to be had in the solid state this objection falls away, and Mr. Watt thinks that the cold process might be fairly reconsidered.

Morfit's system of soap-making is next described. Its essential principle is the treatment of alkaline carbonates with fatty acids at a high temperature. The oleic acid from cotton-oil is especially recommended by the inventor.

A curious procedure was devised about a quarter of a century ago by Dr. Kottula. He adds to common soaps fatty matters, lime-liquor, sal-ammoniac, and alum. The author rightly calls in question the principle of this invention. Sal-ammoniac, boiled in lime-water, must be rapidly decomposed, whilst alum added to soda leys will yield sodium and aluminium sulphate.

The preparation of so-called silicated soaps, *i.e.*, soaps containing an admixture of silicate of soda, is next described. This addition was first suggested by Sheridan, but his methods were subsequently improved on by Gossage, of Widnes. The author, after describing the processes employed, remarks very justly that whenever soluble glass is employed the silica becomes separated out in washing, and leaves a deposit upon the articles washed. He might have added that textile fibres thus treated suffer abrasion, which in the case of wool and silk greatly injures their lustre. Some decided adulterants are next discussed, such as potato-farina and China-clay.

A much more interesting chapter is that devoted to saponification under pressure. We next come back to more sophistications, some of them of a disgusting nature. Thus four patents have been taken out, all by Frenchmen, for soaps containing slaughter-house offal. It scarcely need be said that nitrogenous animal matter inevitably putrefies in contact with alkalies. The changes produced will vary greatly according to the circumstances, and under conditions easily conceivable injury to health may ensue.

The composition of the soaps suitable for clearing madder-purples, and reds, and for ungumming silks, is given somewhat strangely among the soft soaps. A. M. Loch gives a formula for soft soaps into which sal-ammoniac and potassium dinoxalate as well as turpentine and Irish moss are to be introduced.

Toilet soaps, hard, soft, and liquid, are described at great length. Some of the receipts here given are quite practicable upon the small scale, and may prove very useful to chemists and druggists, perfumers, &c.

The twenty-third chapter gives an account of many miscellaneous processes, some of which, as the author intimates, bear the brand of absurdity very plainly. It is, indeed, curious to note what unlikely and unsuitable substances patentees have proposed to introduce into soaps. We have already had occasion to mention sal-ammoniac and alum; but we read now of saw-dust, chlorate of potash, "or any other substance which in process of solution in water will give off oxygen," "anthracine salt," gluten, liquid ammonia, steatite, tar, &c.

We have next instructions for alkalimetry and for the analysis of soaps. It is recommended, in order to determine the insoluble impurities in soap, to dissolve 100 grains of the sample in alcohol. This process will detect most of the substances used as adulterants. But it is unfortunately added in a foot-note that "good methylated spirit answers equally well, and is much cheaper than alcohol." But, except to large consumers who can find heavy security, it is not easy to obtain methylated spirit free from shellac. Darcet's method for determining the fatty acids by the acid of pure white wax is here given, and is very satisfactory.

After giving an account of the processes for bleaching oils, and for recovering glycerin from spent lyes, we find a chapter on "Miscellaneous Soaps," which seems here somewhat out of place, and might very fitly have been incorporated with earlier sections of the work. It contains directions for making soaps for the woollen trade, taken from a work by Philip Kürten written in very bad English. The author points out the error committed by Kürten in recommending soda-soaps for such purposes.

We consider that this work will prove very useful, not merely to the technological student, but to the practical soap-boiler, who wishes to understand the theory of his art and to become acquainted with the procedures followed in different countries as well as with the various proposals for improvement.

In case of a second edition, we may suggest that a bibliography of works, memoirs, &c., bearing on the subject would prove a useful appendix.

CORRESPONDENCE.

ZINC IN DRINKING WATER.

To the Editor of the Chemical News.

Sir,—After perusal of Mr. C. W. Heaton's note on the water at Cwmfelin contained in the Chemical News, vol. xlix., p. 85, the following, taken from an old laboratory note-book, may be of interest:—

Engaged to report on mineral properties in the Mendips in 1875 I had only an extemporised accommodation for making approximate analyses. I employed a soft rain-water from a cistern attached to the house, and stored this water in galvanised iron buckets. During an absence of three weeks, about two litres of this soft rain-water had been allowed to remain in such a galvanised iron bucket, and on my return attracted my attention by containing an abundant white flocculent precipitate. Collected and dried at 100° C., I obtained 3·25 grms. of an oxidised product of zinc, but unfortunately I did not carry the investigation further, neither as regards any peculiar properties of the water employed, nor the exact composition of this zinc salt.—I am, &c.,

J. Lainson Wills.

Caylus, Tarn et Garonne, France.
Feb. 25, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 11.

The Percentage of Alcohol and Extract in the Wines of Anjou.—A. Bouchard.—Analyses of wines from the vineyards of the Layon and the Loire.

Influence of Temperature upon the Fermentation of Must.—Dr. H. Müller.—The fermentation is completed the more rapidly the higher the temperature, whether the must is rich or poor in sugar. The fermentation is most violent at 27°. By using a high temperature it is possible to conduct the fermentation in such a manner that from musts containing a high proportion of

sugar wines may be obtained relatively low in alcohol, but still sweet, and incapable of further fermentation.

Vol. xiii., Part 1.

Pollution of the Water of Great Rivers by Town Sewage and the Self-purification of Rivers.—Dr. Franz Hulwa.—The author has examined the water of the Oder above Breslau, including the point where the supply for the town is pumped up, in its course through the town, below the sewage outfall, and at the distance of 14 kilos. lower down. He considers that a good water should contain in 100,000 parts not more than 50 parts total residue, 1·5 of nitric acid, and 3 parts chlorine, and mere traces of ammonia, albumenoid ammonia, and nitrous acid. For oxidation it should not require more than 0·25 part oxygen. From Ohlau down to a little above Breslau the water undergoes a slight but appreciable deterioration, yet after filtration it is quite suitable for domestic uses. In passing through the city there is a continuous change for the worse, manifested by the increase of oxidisable matter, and by the higher proportion of ammonia and nitric and nitrous acids. Below the sewer outfalls the water is exceedingly impure; there is an increase of total solids, of oxidisable matter, and of chlorine, whilst the ammonia and albumenoid ammonia are augmented a hundredfold. Microscopic examination detected the abundant presence of organisms of putrefaction. Further down was observed a gradual process of self-purification by contact with atmospheric oxygen along with the co-operation of vegetable and animal life in the stream. 14 kilos. below Breslau the influence of the sewage could no longer be detected either chemically or microscopically, the water being of the same composition as at the supply station above the city.

The Morphology and Chemistry of Natural and Artificial Ulmic Compounds.—Dr. J. J. Früh.—The author recognises two forms of peat, the granular and the homogeneous. The humoid bodies separated from peat are distinguished from those artificially obtained by the presence of nitrogen and their greater solubility in alcohol and water.

The Formation of Fat from Carbohydrates in the Animal Body.—N. Tschirwinsky, E. Meissl, and F. Strohmer.—The authors prove experimentally that the quantity of fat formed from carbohydrates is seven to eight times greater than that introduced into the system as such, or formed from the decomposition of albumenoids.

A Physical Property of Milk.—G. Recknagel.—The author has examined the thickening which takes place in milk after it has been drawn from the udder, irrespective of changes of temperature. If the freshly-drawn milk is kept at a temperature of about 15° the process of condensation is continued for two days at a decreasing rate, and extends to 0·8° to 1·5° of Quevenne's scale. The richer the milk the greater is the change. It is accelerated by a lower temperature, and at 5° is complete in six hours. The author ascribes this change to a swelling of the caseine.

Experiments on Digestive Processes in the Stomach and Bowel.—M. Ogata, Dr. Edinger, Dr. Falk, and others.—Digestion and the resorption of albumen given in the form of meat is not affected by the absence of bile. The resorption of carbohydrates given in the form of glucose or bread is likewise not interfered with. On the other hand the resorption of fat is greatly compromised. The bile does not appear to possess any antiseptic property. Its composition is not directly or essentially affected by the food. The quantity of the dry matter in the bile depends on the reception of food.

The Exciting Effects of Oats.—M. Sanson.—From the *Comptes Rendus*.

Observations on Various Diseases of Animals.—MM. Rotoff, Gibeir, and Israel.—This memoir possesses no chemical interest.

The Nutritive Value of Dried Diffusion Residues—Prof. Maercker.—Not adapted for abstraction.

The Nature and Action of the Poison of Lupins.—Dr. Arnold and Dr. Schneidemuhl.—The name lupinotoxine is proposed for this poisonous principle. It proves fatal to dogs in doses of from 2 to 5 grms.

Experiments on the Cultivation and Manuring of Different Kinds of Beets.—Prof. A. Nowoczek.—The author concludes that different soils and climates require different varieties of beet to yield a maximum crop. Knauer's electoral is mentioned as giving the highest proportion of sugar (betose).

The Action of Light on the Evolution of Oxygen in Plants.—J. Reinke.—A summary of the results obtained by Pringsheim.

Crystalline Secondary Pigments accompanying Chlorophyll.—J. Borodin.—A micro-chemical study of the dark green, yellow, red, and violet crystals obtained from extracts of plants in alcohol or benzin.

The Withering of Blossoms and Leaf-shoots.—Julius Wiesner.—Not adapted for abstraction.

Behaviour of the readily Oxidisable Constituents of the Sap of Plants.—C. Kraus.—The facts observed point to the existence of a chromogen, which is converted into a colouring-matter by oxidation within the cells.

Lime and Magnesia in Plants.—Dr. E. von Raumer.—According to the author's observations the function of lime is the production from the available plant-food of structural materials, especially for increasing and strengthening the cell-walls. The function of magnesia consists in the transmission of starch and in the formation of chlorophyll.

Importance of the Capture of Insects for Drosera rotundifolia.—Dr. H. Busgen.—A biological paper.

Phylloxera vastatrix and its Destruction.—A summary of the results obtained with various methods proposed for the destruction of this parasite.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 2, January 20, 1884.

This issue consists entirely of extracts from other journals.

No. 3, February 5, 1884.

Experiments on the Combustion of the Diamond.—C. Friedel.—The author's results agree entirely with those formerly obtained by MM. Dumas and Stas, as well as with the more recent determinations of MM. Roscoe and Schützenberger.

A Reply to the Reclamations of Priority of MM. Vincent and Delachanal.—F. Sestini.—The author refers to his memoir on the formation of the sulphocarbonates published in 1871, ten years before the date of their patent.

Sophistication of Tartar Emetic.—J. Casthelaz.—The substance of this communication has been already inserted.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—Powder of silver and of iodoform intimately mixed and moistened with a little water evolves acetylene, even in the cold. All metals having an affinity for iodine give an analogous reaction and produce metallic iodides.

Neutralisation-heat of Hydrofluoric Acid with the Alkaline and Earthy-alkaline Bases.—M. Guntz.—The value found for ammonia is +15·2 cals.; that of baryta, +17·4 cals.; strontia, +17·9 cals.; and lime, +18·6 cals.

Development of a Schistous Structure in Compressed Bodies.—Ed. Jannettaz.—A schistous structure has been produced by pressure in clay, graphite, talc, steatite, and in various metals.

NOTES AND QUERIES.

Oxygen.—Could any of your readers kindly tell me the best plan of making oxygen on the large scale by either Mallet, Maréchal, or Tessié du Motay's process, and if the latter method is patented or not? If they are worked in England, where?—T. F. C.

Hyposulphate of Soda: Oxysulphate of Lead.—Can any of your readers inform me where hyposul*phate* (not phite) of soda is manufactured? Also where the basic or oxysulphate of lead is manufactured? and the prices of these two substances, viz., lead and hyposulphate of soda?—J. H. R.

MEETINGS FOR THE WEEK

SATURDAY, Mar. 1.—Royal Medical and Chirurgical, 8. (Anniversary.)
MONDAY, Mar. 3rd.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Building of London Houses," by Robert W. Edis, F.S.A.
— Royal Institution, 3. "Scenery of the British Isles," by Prof. A. Geikie. General Monthly Meeting, 5 p.m.
Society of Chemical Industry, 8 p.m. "On the Manufacture of Cuprammonium and Zinc-ammonium, and their Uses." "On the Filtration of Potable Waters." "On some Applications of Keiselghur."
TUESDAY, 4th.—Institute of Civil Engineers, 8.
— Pathological, 8.30
— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
WEDNESDAY, 5th.—Society of Arts, 8. "The Progress of Electric Lighting," by W. H. Preece, F.R.S.
— Geological, 8.
— Pharmaceutical, 8.
THURSDAY, 6th.—Royal, 4.30.
— Royal Institution, 3. "The Older Electricity,' by Prof. Tyndall.
— London Institution, 7.
— Chemical, 8. "Studies on Sulphonic Acids. No. 1. On the Hydrolysis of Sulpho-compounds, and on the Recovery of the Benzines from their Sulphonic Acid," by Dr. Armstrong and Dr. Miller. "Note on the Behaviour of the Nitrogen of Coal during Destructive Distillation, and a comparison of the Amount of Nitrogen left in Coke of various origin," by Watson Smith. "Note on some Experiments to Determine the Value of Ensilage as a Milk- and Butter-producing Food," by T. Farrington, M.A.
FRIDAY, 7th.—Royal Institution, 8. "Bicycles and Tricycles," by Mr. C. V. Boys, at 9.
— Society of Arts, 8. "The New Bengal Rent Bill," by W. Seton-Karr.
SATURDAY, 8.—Royal Institution, 3. "Photographic Action," by Capt. Abney.
— Physical, 3. "Experiments illustrating an Explanation of Hall's Phenomena," by Mr. Shelford Bidwell. "Note on Hall's Phenomena," by Prof. S. P. Thompson, D.Sc., and Mr. Colman C. Starling.

ROYAL INSTITUTION OF GREAT BRITAIN,
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CAPTAIN ABNEY, R.E., F.R.S., will TO-MORROW (Saturday), MARCH 1, at Three o'clock, begin a Course of Six Lectures on Photographic Action, considered as the work of Radiation.

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Town Hall, Salford,
February 22, 1884.

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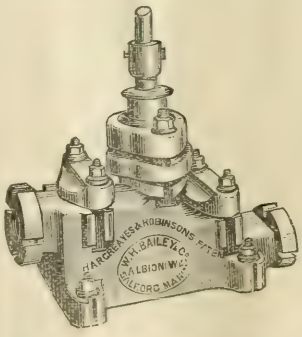

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1267.

ACTION OF WATER ON ZINC: EFFECTS OF DRINKING-WATER CONTAMINATED WITH ZINC.*

By THOMAS STEVENSON, M.D.

THE experiments of Boutigny, Schaueffele, and Langonné have long since shown us that zinc dissolves in potable waters at ordinary temperatures; that distilled water and rain-water dissolve zinc more readily than hard waters, especially those that are rich in chalk. They have shown, however, that hard potable waters do not take up zinc to an appreciable extent, for the zinc speedily becomes coated with an insoluble layer of zinc hydrate (hydrated oxide), or, more commonly, of hydrocarbonate (hydrated oxide and carbonate); but still a portion of the metal remains suspended, whilst a smaller portion, perhaps, passes into a state of true solution. Thus, all kinds of vessels in domestic use, whether made of zinc or "galvanised," impart to waters kept in, or allowed to pass through them, a certain quantity of zinc. The quantity of zinc thus taken up may even be sufficient to render the water opalescent, and unfit for drinking purposes.

Fonssagrives,† taking up the question of the nocuity or innocuity of waters kept in zinc vessels, or in those which are galvanised (*i.e.*, coated with zinc), investigated it by the data furnished by records of the public health, by the experience of naval hygiene, and by experiments on man and upon animals. He does not, however, adduce any experiments of his own. A French Government Commission had previously, on what appeared to Fonssagrives insufficient grounds, decided that water kept in vessels of zinc is injurious to health. Boutigny had likewise attributed very grave effects to the use of waters thus stored, and even imagined that epilepsy might be produced by the ingestion of zinc oxide. Fonssagrives concluded, as the result of his investigations, that the insoluble preparations of zinc produce no digestive disturbances except when taken in large doses, and that they do not accumulate in the economy. He admits that water in contact with metallic zinc becomes coated with zinc compounds, but that these—zinc hydrate, hydrocarbonate, and ulmate—are almost insoluble. Rain-water passing over the metal may, nevertheless, remove some zinc in solution, as zincate of ammonia. These compounds, he states, exist in waters in such small quantities that no injurious effects can, in his opinion, result from their use. He adds that the facts drawn from toxicology, naval hygiene, public hygiene, and therapeutics, all attest the innocuity of water that has rested upon zinc. In consequence, the use of zinc and galvanised iron cisterns, of zinc pipes, and of galvanised iron pipes, for the conveyance of water, cannot be considered dangerous to health.

Others, nevertheless, hold a different opinion. Pappenheim‡ states that, though the amount of zinc present in such waters as have been spoken of is not always sufficient to produce poisonous effects, since it is indubitable that they have frequently been employed for considerable lengths of time with impunity, yet the amount of metal taken up by large quantities of water may be sufficient to produce deleterious results. He states, moreover, that in France, spite of Fonssagrives's assertions, the water tanks of ships have had to be re-galvanised and tinned, and that zinc vessels have to be especially avoided. Dr. Parkes likewise states* that Dr. Osborne, of Bitterne, has frequently observed injurious effects from the use of waters impregnated with zinc.

Of the fact that water does, under certain conditions, act energetically upon zinc and upon galvanised iron, I have had abundant evidence. Some months ago I was consulted by a gentleman relative to the water-supply to his house. The existing supply, from a well on the premises, furnished an excessively hard, chalky, and seleniferous water. It being desirable, for many reasons, to have a soft water, I advised that the rain-water from the extensive slate-covered premises should be filtered and stored for use, as the house was remote from possible sources of contamination of the rain-water. As a matter of precaution, I recommended the use of iron pipes for conveying the water, and that, after filtration through charcoal, sand, and gravel, the water should be stored in a tank lined with asphalt. Against my knowledge, galvanised iron pipes were used instead of those of iron only. The consequence of this has been that the water passing from the reservoir through the galvanised pipes has for many weeks been turbid and milky in appearance. It contains a notable quantity of zinc in suspension, and some in solution. I may remark that zinc in solution in potable waters is best detected by the addition of potassic ferrocyanide to the clear water after acidulation with hydrochloric acid, when a whitish cloud will immediately form if zinc be present. Of course this reaction must be confirmed by other and well-known tests. I know of no test for zinc which is so delicate as this.

What might be the effect of drinking such water as I have described I cannot say, for no one would touch it if other water were to be obtained. Probably, its continued use might be productive of injurious effects.

Engineers should bear in mind this effect of *rain-water* upon zinc and upon the so-called galvanised iron.

* Reprinted from "Guy's Hospital Reports" [3rd Series], vol. xvii. p. 233, 1872.
† *Annals d'Hygiene*, t. xxi., p. 64.
‡ *Handb. d. Sanitätspolizei*, b. ii., p. 765.

NOTES ON A RECENT DISCOVERY OF A PARAFFIN SHALE DEPOSIT IN SERVIA.

By A. B. GRIFFITHS, Ph.D., F.C.S. (London and Paris), Medallist in Chemistry and Botany, &c.

THESE deposits are situated near the River Golabara in the west part of Servia. The shale occurs in upheaved cliffs about 200 feet above the surrounding plains. The formation consists, according to the geologists, engineers, &c., who have inspected it, of hundreds of layers of white and gray shale, one above the other, sometimes being separated by small beds of clay of a whitish colour, containing rock-salt (or "beds of fossil salt" as Lyell liked to call it), and sodium and magnesium sulphides. The extent of this geological formation is very great, extending, as at present discovered, unbroken, over 30 square miles of country. The layers of shale are foliated almost like sheets of paper, this being due, it is said, to the great pressure they have been subjected to during their formation or subsequent. I am given to understand that the whole territory in this part of the country strongly resembles the paraffin and salts districts of Galicia. These Servian deposits are rich in paraffin, and have remained unobserved until about a year ago; but it has been known for ages that cattle, birds, and other animals have been in the habit of resorting to these cliffs and eating the clay containing the rock-salt.

This paraffin shale is entirely free from bituminous impurities, and is of a nearly white colour; it has no odour.

When this shale is heated to about 800° F. (426° C.) it takes fire and burns with a clear bright and smokeless flame, leaving a gray ash behind.

It is very difficult to say what is the origin of the paraffin in these deposits, but most likely it is of vegetable origin,

* "Manual of Hygiene," 3rd edit., p. 12.

having been produced from the distillation of the old brown coals which abound in the vicinity of the deposits.

Eruptive porphyry and trachytic rocks are plentiful at a distance of five or six miles. The deposits of paraffin shale are of marine origin and of the Eocene period. The eruptive rocks just alluded to protrude into these deposits and are of a later date than the deposits themselves. In the clay beds (which is peculiarly free from ferric oxide) large numbers of the genera Ostrea, Cerithium, Cyrena, Nautilus, Pleurotoma, Voluta, Cancellaria, &c., with the fossil remains of various sea-fish belonging to this geological age are to be found. The clays of this area, from which the shales were originally formed, contain innumerable microscopic siliceous shells of marine Diatomaceæ, with the calcareous shells of Foraminifera (principally of the genus Nummulites), and it is supposed to be similar to the ooze now forming at the bottom of the Atlantic and other oceans. It is thought that in the limestone rocks which underlie these shale deposits, rock-salt and petroleum wells will be found. I may say that it is highly probable that all the deposits of the neighbourhood are more or less of organic origin (limestones, shales, brown-coal, paraffin, &c.), or as the poet Byron says—

"The dust we tread upon was once alive,

A sample of this paraffin shale yielded on distillation 2 per cent of a semi-solid hydrocarbon, somewhat similar in appearance to ozokerite wax, which on extracting with "benzoline" gave 1·75 per cent of wax. It also contains 3·02 per cent of water of combination, and 1·18 per cent of ammonia. The remaining ingredients being mineral constituents.

It is stated that the mineral constituents of this paraffin shale deposit would make a useful hydraulic cement. The shale could be extracted by open quarrying "at the cost of a few pence per ton."

Further, the engineers who have inspected the district, say that in distilling the shale on the spot, now that gas-retorts are in use, the shale itself can be utilised as fuel. The formation is so situated that it is in easy access of the Rivers Sawa and Danube. These notes may be of some use to the readers of this journal, for the geology, &c., of this part of Europe is little known.

ON A

NEW FORM OF GAS ASSAY FURNACE.

By WALTER LEE BROWN.

In the CHEMICAL NEWS, vol. xlviii., p. 7, in the course of an article entitled "A New Volumetric Method for Estimating Arsenic," Prof. Leroy W. McCay makes the following statement concerning the determination of the silver in the arseniate by cupellation:—"This will do very well for large works like the Freiberger-Hütten, where muffles are running day and night, but in establishments not provided with furnaces of this kind, or in laboratories provided with them but only capable of firing up at certain seasons, the impossibility of a general and constant applicability of the process is at once evident."

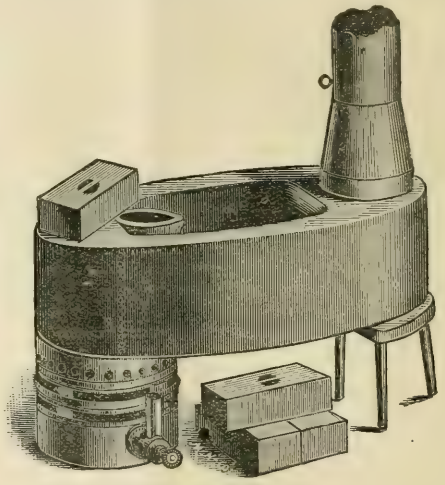
I have quoted the above in full because it embodies in plain language the same complaint which has many times been brought to my notice. My sole comment upon it is to advise Prof. McCay and any others to read my description of the simple but satisfactory little furnace represented here.

Let me first state that it is not my intention to claim originality as regards this furnace, but merely applicability and decided improvements in the form. It was Mr. Thomas Fletcher, of Warrington, England, to whom we are indebted for so many ingenious forms of apparatus for the utilisation of illuminating gas as a medium of heat, who devised the original furnace which I employed successfully in assaying for a year and a half. Its chief fault lay in the fact that but one scorifier or cupel could be operated at a time. This furnace had almost entirely escaped attention as an assay furnace, owing to its having been advertised mainly for melting small quantities of lead, copper, brass, &c., and in fact had been withdrawn from the market when I took hold of it.

With the idea of improving it so that it should be able to treat three or four or more scorifiers or cupels at once, and so be of great benefit to those desiring a furnace for small runnings, the present furnace was finally constructed.

As shown, the form is almost that of the reverberatory furnace, the movable bricks when in place forming the roof. From another point of view, it may be described as the muffle of an ordinary furnace, but having the flame as well as the heat inside. The exterior dimensions are as follows:—20 inches long, 7 inches wide, and 5½ inches deep. The nozzle at the burner is connected with a ⅜ inch tap by means of a full ½ inch rubber tube. A 3-inch stove-pipe, *tightly fitting*, is connected with a flue.

In the interior, upon the floor, rest four little wedge-shaped pieces of fire-clay which are movable, and upon them rests a false floor, also movable. The latter (not shown in the cut), corresponds to the muffle bottom of an ordinary furnace, and upon it is done all the work. It



is 3½ inches wide by 7½ inches long, and will accommodate three 2¾ inch or four 2¼ inch scorifiers, or eighteen 1¼ inch cupels at once; but like any other furnace, it is better not to crowd it.

The manner of operation is simple. The covering bricks are removed, the milled wheel at the gas entrance to the burner is turned back so to allow a full flow of gas, the handle at the supply tap turned full on, the gas lighted, and the bricks put snugly into place. The flame, when the full amount of gas is used, will be highly carburetted, and of course strongly reducing, but intensely hot. In from fifteen to twenty minutes the interior will be hot enough for work. The bricks are removed, the charged scorifiers placed within, the bricks set back, the excess of gas turned off at the milled wheel, and the furnace kept closed till the charges are melted. After this has been effected, the bricks are separated or slid aside more or less to admit of air for scorification. Proper regulation is made by the milled wheel, by which the gas may be turned partially off as required, always leaving the supply tap fully open. The action of the air is also controlled by the damper in the pipe leading to the chimney.

To cupel, the gas supply is turned down more than in scorifying. The time of performing either scorification or cupellation varies according to the nature of the ore and other circumstances, but is about the same as in the use of a coke furnace.

This furnace does well for small crucible fusions, by removing the false floor and its supports.

The advantages of this furnace are many; convenience of operating whereby the assayer sees every step and stage of the operation, and so can tell when and where to change or improve; perfect control of the source of heat, so that a higher or lower temperature, a reducing or oxidising effect may be produced in an instant; entire noiselessness, in which characteristics it is the superior of all blast assay furnaces; saving of time, which in furnaces employing coke, charcoal, or coal is spent in "bedding down," feeding, &c; freedom from the annoyances of dust and ashes; absence of waste, for when the work is performed the gas is at once shut off; comfort in manipulation, for it does not heat up a room as do most furnaces (quite a desideratum in the summer time); finaliy, its remaining qualifications, which need not be dwelt upon, are simplicity of construction, durability, and portability.

The consumption of gas is not far from 30 cubic feet per hour. It is not intended nor claimed that this furnace can take the place of one required to be run from ten to twelve hours per day, for here, of course, a solid fuel will be cheaper, but for small runnings of from one to three hours or so it is economical with gas as high as 3 dols. per thousand, and much more so when the latter is as cheap as it is in England.

The few furnace tools required can easily be made from quarter-inch wire.

The furnace sells for 20 dols., and is made by the Buffalo Dental Manufacturing Co., of Buffalo, N.Y. I can only say further that the furnace is really a beautiful piece of work and delights everyone who sees it in operation.

Chicago, Ill., January 31, 1884.

ON ELECTROLYSIS.

By H. SCHUCHT.

Concerning the separations which take place at the positive pole, the composition of the peroxides and the manner of their determination, relatively little has been done.

If solutions of the salts of lead, thallium, silver, bismuth, nickel, and cobalt, are decomposed by the current between platinum electrodes, metal is deposited at the negative, and oxide at the positive electrode. Manganese is precipitated only as peroxide. The formation of peroxide is, of course, effected by the ozone found in the electrolytic oxygen at the positive pole; the oxide existing in solution is brought to a higher degree of oxidation and is separated out. Its formation may be decreased or entirely prevented by the addition of readily oxidisable bodies, such as organic acids, lactose, glycerin, and preferably by an excess of oxalic acid; but only until the organic matter is transformed into carbonic acid. In this manner Classen separates other metals from manganese in order to prevent the saline solutions from being retained by the peroxide.

With solutions of silver, bismuth, nickel, and cobalt, it is often practicable to prevent the separation of oxide by giving the current a greater resistance—increasing the distance between the electrodes.

The proportion between the quantities of metal and of peroxide deposited is not constant, and even if we disregard the concentration of the solution, the strength of the current and secondary influences (action of nascent hydrogen) is different in acid and in alkaline solutions. In acid solutions much peroxide is formed; in alkaline liquids, little or none. The reason of the difference is that ozone is evolved principally in acid solutions, but appears in small quantities only in alkaline liquids, or under certain circumstances not at all. The quantity of peroxide deposited depends also on the temperature of the saline solution; at ordinary temperatures the author obtained more peroxide—the solution, the time, and the strength of current being equal—than from a heated liquid. The cause is that ozone is destroyed by heat and converted into ordinary oxygen. With the exception of lead and thallium the quantity of metal deposited from an acid solution is always greater than that of the peroxide.

Lead.—Luckow has shown that from acid solutions—no matter what may be the acid—lead is deposited at the anode as a mixture of anhydrous and hydrated peroxide of variable composition. Only very strongly acid solutions let all their lead fall down as peroxide; the precipitation is rapid immediately on closing the circuit, and complete separation is effected only in presence of at least 10 per cent of free nitric acid. As the current becomes stronger with the increase of free acid there is deposited upon the first compact layer a new stratum of loosely adhering peroxide.

In presence of small quantities of other metals which are thrown down by the current in the metallic state, such as copper, mercury, &c., peroxide alone is deposited from a solution of lead containing small quantities only of free nitric acid.

The lead peroxide deposited is at first light brown or dark red, and becomes constantly darker and finally taking a velvet-black. As its stratification upon the platinum is unequal it forms beautifully coloured rings.

Experiments show that the quantity of peroxide deposited depends on the nature of the solution and the strength of the current. In case of very feeble currents and slight acidity, its quantity is so small that it does not need to be taken into consideration. If the lead solution is very dilute scarcely any current is observed, lead solutions *per se* being very bad conductors of electricity.

Faintly acid concentrated lead solutions give loose peroxide along with much spongy metallic lead. Free alkali decreases the separation of peroxide; feebly alkaline solutions, concentrated and dilute, yield relatively much peroxide along with metallic lead, whilst strongly alkaline solutions deposit no peroxide.

Dried lead peroxide is so sparingly hygroscopic that it may be weighed as such; its weight remains constant upon the balance for a long time. In order to apply the peroxide for quantitative determinations a large surface must be exposed to action. As positive electrode a platinum capsule is convenient and a platinum disc as negative pole. The capsule shape is necessary because the peroxide when deposited in large quantities adheres only partially, and falls in part in thin loose scales. It is necessary to syphon off the nitric solution, since, like all peroxides, that of lead is not absolutely insoluble in nitric acid. The methods of Riche and May give results which are always too high, since portions of saline solution are retained by the spongy deposit and can be but very imperfectly removed by washing. This is especially the case in presence of free alkali.

The author has proceeded as follows:—The lead peroxide is dried in the capsule and there is passed over it pure dry gaseous sulphurous acid in a strong current from a rather narrow delivery tube. Lead sulphate is formed with evolution of heat; it is let cool under the exsiccator and weighed as such. Or he ignites the peroxide along with finely pulverised ammonium sulphite; the mass must have a pure white colour. After the conclusion of the reaction it is ignited for about 20 minutes. The results are too high. The proportion of actual lead peroxide in the deposit ranges from 94 to 94·76 per cent. The peroxide precipitated from a nitric solution may, under certain circumstances, be anhydrous. This result is due to the secondary influences at the positive pole where the free acid gradually withdraws water from the peroxide.

The peroxide thrown down from alkaline solutions retains alkali so obstinately that it cannot be removed by washing; the peroxide plays here the part of an acid. The lead nitrate mechanically inclosed in the peroxide is resolved by ignition into oxide, hyponitric acid, and oxygen; this small proportion of lead oxide does not exert an important influence on the final result. The quantity of matter mechanically inclosed is relatively high, as in the precipitation of much lead peroxide there is relatively more

saline matter occluded than when a few centigrammes are deposited. The peroxide incloses also more foreign matter if it is thrown down upon a small surface than if it s deposited in a thin layer over a broad surface. From numerous analyses the auther concludes that in presence of much free nitric acid the proportion of water is increased; with free alkali the reverse holds good.

Thallium behaves similarly to lead. From a nitric acid solution it is thrown down, according to the proportion of free acid, either as sesquioxide only or in small quantities as silvery, metallic leaflets; from alkaline solutions it is deposited as sesquioxide and metal, the latter of a lead-grey colour. Thallium solutions conduct the electric current badly. Thallium oxide resembles lead peroxide in colour; at a strong heat it melts, becomes darker, and is converted into peroxide, in which state it can be weighed.

Silver.—All solutions of silver salts, except the nitrate, and those containing a very large quantity of free nitric acid or nitrates, deposit electrolytically merely metallic silver. In the above-mentioned exceptional cases there is formed a small quantity of peroxide which adheres to the anode as a blackish grey deposit. The greatest quantity of peroxide is obtained on employing a concentrated, strongly acid solution of the nitrate, and a strong current. If the solution is very dilute we obtain no peroxide, or mere traces which disappear again towards the end of the process. The peroxide is deposited at first in small, dark, shining octahedral crystals; subsequently, in an amorphous state. At 110° it evolves oxygen suddenly and is converted into metallic silver. It dissolves in ammonia with a violent escape of nitrogen. In nitric acid it dissolves without decomposition and with a red colour.

The author uses a galvanic current for reducing silver-residues, consisting of sulphocyanide. The salt is mixed with sulphuric acid in a roomy platinum capsule, and a fine platinum wire gauze is used as positive electrode.

Bismuth.—The current resolves bismuth solutions into metal and bismuthic acid. The latter is deposited at the positive pole, and in thin layers appears of a golden-yellow, but in thick strata is darker, approaching to red. Its formation is very gradual, and in time it disappears again, owing to secondary actions of the current. On ignition it becomes lemon-yellow, and transitorily darker, even brown, and passes into the sesquioxide.

Nickel and Cobalt.—On the electrolysis of the ammoniacal solution the sesquioxide appears at the positive pole. Its formation is prevented by an excess of ammonia. The auther never obtained more than 3½ per cent of the quantity of the metal. The sesquioxides dissolve in ammonia without escape of nitrogen and are usually anhydrous.

Manganese.—Manganese is the only metal which is precipitated only as peroxide. It is deposited at once on closing the circuit and is at first brown, then black and shining. Organic acids, ferrous oxide, chromic oxide, ammmonium salts, &c., prevent the formation of peroxide and the red colour produced by permanganic acid. In very dilute strongly acid nitric solutions there is formed only permanganic acid which, according to Riche, is plainly visible in solutions containing $\frac{1}{100000}$ grm. manganese. On electrolysing a manganiferous solution of copper nitrate red permanganic acid appeared in a stratum floating above the platinum disc coated with brown peroxide. No manganese peroxide was deposited. The peroxide adheres firmly to the platinum when the proportion of free acid is small, not exceeding 3 per cent, and the current is not too strong. If the action of the current is prolonged after the peroxide is thrown down, it falls off in laminæ. According to Riche, in a nitric solution the manganese is deposited as peroxide, also at the negative pole. This formation is not directly due to the current, but is a precipitate occasioned by the production of ammonia by the reduction of nitric acid. To determine the manganese in peroxide electrolytically precipitated, it is heated to bright redness in the platinum capsule until the weight becomes constant. The results are too high.

Selenium and Tellurium.—Both these bodies are readily and completely reduced by the current either in acid or alkaline solutions. Selenium is thrown down at first of a fine brownish red, which gradually becomes darker. The deposit of tellurium is of a bluish black colour. If the current is feeble the deposit of selenium is moderately compact; that of tellurium is always loose, and it often floats on the liquid. A strong current precipitates both as powders. The positive pole is coated during electrolysis with a film of a dark colour in case of selenium, but of a lemon-yellow with tellurium. As in case of arsenic and antimony the hydrogen evolved at the negative pole combines with the reduced substances, forming hydrogen, selenide, or telluride, which remain in part in solution in the liquid. The reduced metal separates out at the anode in a friable condition.—*Zeitschrift für Analytische Chemie.*

METHOD FOR THE DIRECT DETERMINATION OF CHLORINE IN PRESENCE OF BROMINE AND OF BROMINE ALONG WITH IODINE.

By G. VORTMANN.

THE author some time back made known a method for the detection and determination of chlorine in presence of bromine and iodine, based on the various behaviour of the three halogens with manganese and lead peroxide in presence of acetic acid. On boiling with lead peroxide and acetic acid the chlorides remain unaffected, whilst the bromides and iodides are completely decomposed, with liberation of bromine and iodine. Manganese peroxide, in presence of acetic acid, is said to act only upon the iodides.

C. L. Müller and G. Kircher have submitted this method to investigation. As regards the action of lead peroxide and acetic acid upon the chlorides, they found that upon boiling such mixtures chlorine is given off in abundance along with carbonic acid, whether the acid employed was glacial or containing from 50 to 10 per cent of real acid. One part sodium chloride boiled for six hours with 10 parts lead peroxide and 20 parts acetic acid at 50 per cent in a cohobator was found to contain only two-thirds of the chlorine originally present. In accordance with their experiments the authors explain this fact by the circumstance that in such proportions sodium chloride and acetic acid yield hydrochloric acid, that this in presence of lead peroxide evolves chlorine, which, reacting upon the acetic acid, forms mono-chloracetic acid, which is in part oxidised with formation of lead chloride, carbonic acid, and free chlorine.

If manganese peroxide is substituted for the lead compound, sodium chloride is, indeed, decomposed, but carbonic acid escapes alone, without chlorine.

Müller and Kircher confirm Vortmann's statement that lead peroxide in presence of acetic acid decomposes the bromides and iodides, whilst, according to their experiments, manganese peroxide and acetic acid act, not upon the iodides alone, but upon the bromides also.

Vortmann has now replied in an elaborate memoir. His observations agree with those of Müller and Kircher so far that, on boiling potassium chloride, lead peroxide, and acetic acid, a perceptible escape of chlorine occurs if the concentration of the acetic acid is over 5 per cent. He finds that not a trace of potassium chloride is decomposed if acetic acid of at most 2 to 3 per cent is employed, and the mixture is evaporated on the water-bath. Even on repeating this process five or six times no loss of chlorine is experienced. The remaining chlorides behave like potassium chloride.

Concerning the behaviour of the chlorides with manganese peroxide and acetic acid, Vortmann states that in presence of strong acetic acid a slight decomposition

occurs, whilst if the acid is dilute there is not the slightest action.

Vortmann corrects his previous statements concerning the behaviour of the bromides to this effect, that they are attacked by manganese peroxide and strongly concentrated acetic acid, but with a dilute acid of 2 to 3 per cent they do not undergo any change.

If the solution of a bromide is mixed with lead peroxide and dilute acetic acid, bromine is immediately liberated, especially if the reaction is assisted by heat. On boiling or evaporation, bromine escapes, so that it is practicable on repeatedly evaporating to dryness on the water-bath, entirely to expel quantities of bromine corresponding to 0·5 potassium bromide. In case of larger quantities of bromine, a twice-repeated evaporation is not sufficient. The reason is that considerable quantities of lead acetate in solution impede the decomposition of the bromide, since the liquid can only be evaporated to a syrup. In such cases the repeated evaporation is dispensed with, and the dissolved lead is thrown down by means of hydrogen sulphide; the precipitate of lead sulphide is then again evaporated down with lead peroxide and acetic acid, when finally the last trace of bromine is driven off.

The decomposition of the iodides by treatment with lead peroxide and acetic acid is complete only when so much lead peroxide is added as corresponds with the following equation:—

$$KI + PbO_2 = PbO + KO + I,$$

and the mixture is heated for some time to boiling. In the cold no lead iodate is produced by an excess of lead peroxide; on boiling, however, the iodine is partly oxidised, and considerable quantities of lead iodate are formed; relatively to a greater extent the more iodine is present, small quantities of iodine can be eliminated without oxidation. Manganese peroxide acts upon the iodides much more feebly than does lead peroxide. The decomposition in presence of acetic acid is slower, and there is no formation of iodic acid.

Mixtures of iodides and bromides in acetic solution behave with maganese peroxide like the iodides alone, *i.e.*, iodine alone is eliminated. On applying an excess of lead peroxide, on the other hand, there is simultaneous expulsion of bromine and iodine, which then react upon each other with formation of iodic acid. This change takes place even in the cold, and almost the entire quantity of iodine can be thus converted into iodic acid, so that on heating scarcely anything but bromine escapes. The formation of iodic acid may be almost completely avoided by introducing the lead peroxide into the boiling acetic solution in small successive portions, in order thus to decompose first the iodide and then the bromide. Upon these facts Vortmann founds the following analytical methods:—

For determining chlorine in presence of small quantities of bromine the mixture with lead peroxide and acetic acid of 2 to 3 per cent is twice or thrice evaporated to dryness on the water-bath. The residue is taken up with water and a little acetic acid, filtered, washed with hot water, and the filtrate is precipitated with silver nitrate.

The determination of chlorine in presence of iodine is conducted in the same manner. If the quantity of the iodide is small, lead peroxide is used; but if large, manganese peroxide is preferable. The evaporation with dilute acetic acid must here also be repeated several times. The expulsion of iodine is accelerated by boiling the liquid first for a few minutes in a flask, but this procedure is practicable only with lead peroxide, as, in case of manganese peroxide, violent bumping occurs. In this case the mixture is heated on the water-bath, and a current of air is passed through the liquid.

The determination of bromine in presence of iodine is effected in an analogous manner; the mixture is repeatedly evaporated with manganese peroxide and dilute acetic acid on the water-bath, and air is passed through the liquid to expedite the reaction.

The determination of chlorine in presence of bromine and iodine can be effected by two methods:—The mixture is either boiled with lead peroxide and dilute acetic acid, when the iodides and bromides are simultaneously decomposed, or the iodine is first expelled by evaporation with manganese peroxide and acetic acid, and the bromine is then eliminated by repeating the operation with the addition of lead peroxide.

If the former method is adopted, in order to obviate as far as possible the formation of iodic acid by the mutual action of iodine and bromine, the lead peroxide is introduced into the boiling acetic solution in small portions and in slight excess. After boiling for half an hour, and constantly replacing the water lost by evaporation, the lead which has passed into solution is precipitated with hydrogen sulphide, without previous filtration; the whole, after filtration, is heated for some time on the water-bath, again treated for a short time with sulphuretted hydrogen, and filtered. The filtrate is evaporated to dryness on the water-bath, the residue covered with dilute acetic acid, and, after the addition of some lead peroxide, again evaporated. The evaporation is in any case repeated once more, the residue is finally dissolved, and after filtration the chlorine is determined with silver nitrate.

The results are unsatisfactory when a little chlorine occurs along with large quantities of bromine and iodine. In such cases the following procedure is to be preferred:—

The mixture is repeatedly evaporated down on the water-bath with manganese peroxide and acetic acid at 5 per cent to expel iodine; the bromine is then driven off by evaporating—without previous filtration—repeatedly with lead peroxide and acetic acid at 2½ per cent; the ultimate residue is taken up with water and a little acetic acid, and the chlorine is determined in the filtrate.

This method has the defect that, on decomposing the iodides by manganese peroxide, manganese dissolves, and on subsequent treatment with lead peroxide it is re-precipitated as manganese-lead peroxide. This precipitate requires very prolonged washing with boiling water.—*Zeitschrift fur Analytische Chemie.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending January 31st, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, February 6th, 1884.

Sir,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 189 samples of water, the whole were, without exception, clear, bright, and well filtered.

The water supplied to the Metropolis during January has mantained much the same character as that manifested by the supply of the preceding month; its degree of freedom from organic matter, however, being on the whole somewhat less during the latter part than at the beginning of the month.

Our own report on the character of the supply during the preceding month of December, based on an examination of 182 samples, was as follows:—"Altogether, the condition of the Metropolitan water during the past month, in respect to aëration and freedom from colour and turbidity, has been unexceptionable. In one sample only out of those completely analysed (24) was the amount of organic matter at all excessive, while the mean proportion was low—and unusually low for the period of the year."

On the other hand, the report made to the Registrar-General, also on the character of the waters supplied to the Metropolis *during* the month of December, but based on an examination of 7 samples only, all taken on the same one day of the month, was as follows:—"The Thames water sent out by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies, which in the previous two months had exhibited an increased amount of organic matter, again suffered further deterioration in December. . . . . The water drawn from the Lea and distributed by the New River and East London Companies, underwent a similar, but in the case of the New River, a less marked deterioration, whilst the East London Company's water was scarcely superior to any of the Thames waters."

We have no hesitation in calling attention to the discordance between the two reports; or to the circumstance that, according to the report to the Registrar-General, the mean amount of organic carbon in the Thames derived waters supplied *during* the month of December, 1883, or 0·246 part in 100,000 parts of the water, was identical with the mean amount of organic carbon in the Thames derived waters supplied *during* the month of December, 1882; notwithstanding that throughout December, 1882, the river was in a quite exceptional state of turbidity and flood; whereas at no part of the month of December, 1883, was it in a bad condition for the time of the year, while its condition during the latter part of the month was exceptionally good.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

URANIUM.

IT is not the purpose of the present investigation to examine at all systematically such questions as are involved in the discussion whether the atomic weight of uranium is 120 or 240. For convenience we may use the formulæ based upon the smaller number, and, if eventually the larger value proves to be correct, it will be easy to double the figures which we obtain. Suffice it to say here, that the specific heat of the green oxide, according to Donath,† agrees best with the formula U_3O_4 and the lower atomic weight. On the other hand, the value 240 fits best into such schemes as that given by Mendelejeff in his paper on the periodic law. An accurate determination of the specific heat of the metal itself is much needed, for the material with which Regnault worked was of uncertain quality; furthermore, the vapour density of some volatile uranium compounds ought to be ascertained.* Until some such data have been rigidly established the controversy over the two rival values can hardly be satisfactorily settled.

The earlier attempts to determine the atomic weight of uranium were all vitiated by the erroneous supposition that the uranous oxide was really the metal. The supposition, of course, does not affect the weighings and analytical data which were obtained, although these, from their discordance with each other and with later and better results, have now only a historical value.

For present purposes the determinations made by Berzelius,† by Arfvedson,‡ and by Marchand,‖ may be left quite out of account. Berzelius employed various methods, while the others relied upon estimating the percentage of oxygen lost upon the reduction of U_3O_4 to UO. Rammelsberg's§ results also, although very suggestive, need no full discussion. He analysed the green chloride, UCl_2; effected the synthesis of uranyl-sulphate from uranous oxide; determined the amount of residue left upon the ignition of the sodio- and bario-uranic acetates; estimated the quantity of magnesium uranate formed from a known weight of UO, and attempted also to fix the ratio between the green and the black oxides. His figures vary so widely that they could count for little in the establishing of any general mean; and, moreover, they lead to estimates of the atomic weight which are mostly below the true value. For instance, twelve lots of U_3O_4 from several different sources were reduced to UO by heating in hydrogen. The percentages of loss varied from 3·83 to 4·67, the mean being 4·121. These figures give values for the atomic weight of uranium ranging from 92·66 to 117·65, or, in mean, 107·59. Such discordance is due partly to impurity in some of the material studied, and illustrates the difficulties inherent in the problem to be solved. Some of the uranoso-uranic oxide was prepared by calcining the oxalate, and retained an admixture of carbon. Many such points were worked up by Rammelsberg with much care, so that his papers should be scrupulously studied by any chemist who contemplates a re-determination of the atomic weight of uranium.

In 1841 and 1842 Peligot published certain papers¶ showing that the atomic weight of uranium must be somewhere near 120. A few years later the same chemist published fuller data concerning the constant in question, but in the time intervening between his earlier and his final researches other determinations were made by Ebelmen and by Wertheim. These investigations we may properly discuss in chronological order. For present purposes the early work of Peligot may be dismissed as only preliminary in character. It showed that what had been previously regarded as metallic uranium was in reality an oxide, but gave figures for the atomic weight of the metal which were merely approximations.

Ebelmen's** determinations of the atomic weight of uranium were based upon analyses of uranic oxalate. This salt was dried at 100°, and then, in weighed amount, ignited in hydrogen. The residual uranous oxide was

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Ber. d. Deutsch. Chem. Gessel.*, 12, 742. 1879.

* The value of 240 for uranium is strongly sustained by the recent experiments of Zimmermann upon the vapour density of the tetrachloride and tetrabromide. For UBr_4 the vapour density is 19·46, while theory (U=240) requires 19·36. For UCl_4 the v. d. 13·33 was found. Theory, 13·21. (*Ber. der Deutsch. Chem. Gessel.*, 14, s. 1934 1881.) Zimmermann has also (*Ber.*, 15, 847) determined the specific heat of uranium, and finds it to be 0·02765. This, multiplied by 240, gives 6·64, in agreement with the usual values under Dulong and Petit's law.

† *Schweigg. Journ.*, 22, 336. 1818. *Poggend. Annal.*, 1, 359. 1825.

‡ *Poggend. Annal.*, 1, 245. *Berz. Jahr.*, 3, 120. 1822.

‖ *Journ. f. Prakt. Chem*, 23, 497. 1841.

§ *Poggend. Annal.*, 55, 318; 1842; 56, 125, 1842; 59, 9, 1843; 66, 91, 1845. *Journ. f. Prakt. Chem.*, 29, 324.

¶ *Compt. Rend.*, 12, 735. 1841. *Ann. Chim. Phys.*, (3), 55. 1842.

** *Journ. f. Prakt. Chem.*, 27, 358. 1842.

weighed, and in some cases converted into U_3O_4 by heating in oxygen. The following weights are reduced to a vacuum standard :—

			Gain on Oxidation.
10·1644 grms. oxalate	gave	7·2939 grms. UO.	
12·9985 ,,		9·3312 ,,	0·3685
11·8007 ,,		8·4690 ,,	0·3275
9·9923 ,,		7·1731 ,,	0·2812
11·0887 ,,		7·9610 ,,	0·3105
10·0830 ,,		7·2389 ,,	
6·7940 ,,		4·8766 ,,	
16·0594 ,,		11·5290 ,,	0·4531

Reducing these figures to percentages, we may present the results in two columns. Column A gives the percentages of UO in the oxalate, while B represents the amount of U_3O_4 formed from 100 parts of UO :—

A.	B.
71·924	—
71·787	103·949
71·767	103·867
71·621	103·920
71·794	103·900
71·793	—
71·778	—
71·790	103·930
Mean 71·782 ± 0·019	Mean 103·913 ± 0·009

From col. A the mol. weight of UO = 134·523 ± 0·102
,, B ,, ,, 135·985 0·326

General mean UO = 134·652 0·097

From column A .. .. U = 118·560
,, B .. .. ,, 120·022
From general mean of both columns ,, 118·689 ± 0·097

Wertheim's* experiments were even simpler in character than those of Ebelmen. Sodio-uranic acetate, carefully dried at 200°, was ignited, leaving the following percentages of sodium uranate :—

67·51508
67·54558
67·50927

Mean 67·52331 ± 0·0076

Hence the molecular weight of $Na_2U_4O_7 = 634·865 \pm 0·191$. And $U = 119·282 \pm 0·048$.

The final results of Peligot's† investigations appeared in 1846. Both the oxalate and the acetate of uranium were studied and subjected to combustion analysis. The oxalate was scrupulously purified by repeated crystallisations, and thirteen analyses representing different fractions, were made. Seven of these gave imperfect results, due to incomplete purification of the material; six only, from the later crystallisations, need to be considered. In these the uranium was weighed as U_3O_4, and the carbon as CO_2. From the ratio between the CO_2 and U_3O_4 the atomic weight of uranium may be calculated without involving any error due to traces of moisture possibly present in the oxalate. I subjoin Peligot's weighings, and give, in the third column, the U_3O_4 proportional to 100 parts of CO_2 :—

CO_2.	U_3O_4.	Ratio.
1·456 grms.	4·649 grms.	319·299
1·369 ,,	4·412 ,,	322·279
2·209 ,,	7·084 ,,	320·688
1·019 ,,	3·279 ,,	321·786
1·069 ,,	3·447 ,,	322·461
1·052 ,,	3·389 ,,	322·148
	Mean	321·443 ± 0·338

Hence $U_3O_4 = 423·342 \pm 0·451$.

* *Journ. f. Prakt. Chem.*, 29, 209. 1843.
† *Compt. Rend.*, 22, 487.

From the acetate, $C_2H_3(UO)O_2.H_2O$, the following percentages of U_3O_4 were obtained :—

5·061 grms. acetate	gave	3·354 U_3O_4.	66·2715 per cent.
4·601 ,,		3·057 ,,	66·4421 ,,
1·869 ,,		1·238 ,,	66·2386 ,,
3·817 ,,		2·541 ,,	66·5706 ,,
10·182 ,,		6·757 ,,	66·3622 ,,
4·393 ,,		2·920 ,,	66·4694 ,,
2·868 ,,		1·897 ,,	66·1437 ,,
		Mean	66·3569 ± 0·038

The acetate also yielded the subjoined percentages of carbon and of water. Assuming that the figures for carbon were calculated from known weights of dioxide, with C = 12 and O = 16, I have added a third column, in which the carbon percentages are converted into percentages of CO_2 :—

H_2O.	C.	CO_2.
21·60	11·27	41·323
21·16	11·30	41·433
21·10	11·30	41·433
21·20	11·10	40·700
Mean 21·265 ± 0·187	11·24	Mean 41·222 ± 0·092

From all of these figures we may calculate the molecular weight of the uranic acetate as follows :—

From percentage of U_3O_4.. ..	$C_2H_3(UO)O_2.H_2O$ =	212·629	± 0·242
Ditto CO_2	,,	212·999	0·476
,, H_2O.. ..	,,	211·184	1·863
General mean ..	,,	212·685	0·214

We have now before us the molecular weights of four uranium compounds, giving us four values for U :—

(1.) UO = 134 652 ± 0·097 .. .. Ebelmen.
(2.) $Na_2U_4O_7 = 634·865 \pm 0·191$ .. .. .. Wertheim.
(3.) $U_3O_4 = 423·342 \pm 0·451$ .. .. Peligot.
(4.) $C_2H_3(UO)O_2.H_2O = 212·685 \pm 0·214$ .. ,,

The four values for uranium combine as follows :—

From (1)	U = 118·689 ± 0·097		Ebelmen.
,, (2)	,, 119·282	0·048	Wertheim.
,, (3)	,, 119·830	0·150	Peligot.
,, (4)	,, 119·885	0·215	,,
General mean	,, 119·241	0·041	

Or, if O = 16, U = 119·515, or 239·030.

Considering Peligot's figures by themselves, and combining values 3 and 4, we have U = 119·849 ± 0·123 ; or, if O = 16, U = 120·125, or 240·250.

It is plain that the atomic weight of uranium needs to be scrupulously revised. The foregoing figures are by no means satisfactory. Chemically considered, it is probable that Peligot's work is the best, and that his results should be given preference. His figures from the oxalate and the acetate tally well with each other, whereas Ebelmen's two sets of results vary widely. From the percentage of UO yielded by the oxalate, Ebelmen's figures give a low value for U. From his oxidation of UO to U_3O_4 we get a value nearly two units higher. Peligot, in his work with the oxalate, found it, even after three or four crystallisations, to be contaminated with oxalic acid, and rejected the figures obtained from impure material. Probably Ebelmen's low values are due to the same impurity.

The Action of Chloro-carbonic Oxide upon Æthylen-glycol.—J. Nemirowsky. —The author has obtained glycol carbonate, hitherto unknown, by allowing 1 mol. pure glycol and 1 mol. liquid chloro-carbonic acid to act upon each other in a sealed tube at common temperatures. —*Journal fur Praktische Chemie.*

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, February 23, 1884.

Prof. F. GUTHRIE, President, in the Chair.

NEW Members—Mr. E. F. J. Love, Mr. James Grundy, Rev. F. J. Smith, Mr. F. R. Bawley.

Prof. SILVANUS P. THOMPSON read a paper on "*A New Method of making Resistance Coils.*" This consisted in cutting off a piece of the wire of which the coil is to be made, long enough to give a resistance some 2 per cent higher. From the formula—

$$\text{Shunt} = \frac{R\,r}{R - r}$$

(where R is the rough resistance, and r the final resistance), the value of a wire wherewith to shunt the first piece in order to give the resistance required is found. A length of wire giving this resistance (or rather about 2 per cent more) is then cut off and soldered as a shunt to the first piece. Practice shows that this method is very quick and accurate. It is useful for shunts under 10 ohms.

Prof. THOMPSON also described a new form of "Meter Bridge," devised by him. The wire is 2 metres long, and there are two wires, one of a resistance about $\frac{1}{4}$ ohm, the other 8·21 ohms. Contact is made with one or other by a sliding contact with vernier attached. This arrangement is more convenient than the single wire meter bridge, and allows of higher resistances being measured. A special switch board with an arrangement of mercury cups avoids the necessity of transposing the coils in Foster's method; this being effected by shifting the contact links in the mercury cups.

Mr. R. T. GLAZEBROOK, F.R.S., explained a cam or axle-key, devised by Mr. Shaw, to effect the contacts necessary to transpose the coils by a single movement. He pointed out that a certain pressure was necessary to make good contact with mercury. The ordinary way of making coils was to double the wire, cut the bight, bare the ends there, and solder a piece of copper across them, which could be shifted until the resistance was got.

Prof. G. C. FOSTER said that the copper links in mercury cups should rest on the copper.

Prof. FOSTER read a paper by himself and Mr. PRYSON, "*On the Difference of Potential required to give Sparks in Air.*" Let V = this difference of potential, l = length of spark in centimetres; their experiments gave (approximately), $V = 102\,l + 7{\cdot}07$. Tables and curves of the sparking distances, potentials, and electric forces in the experiments were given. The results were got with brass balls 1·35 centimetres in diameter, a frictional machine, and a Foster absolute electrometer. When $l = 0{\cdot}142$, the electric force giving a spark was 154·76; $l = 0{\cdot}284$, the electric force was 133·35, or less than at a shorter distance; $l = 0{\cdot}497$, the electric force was 131·66: $l = 0{\cdot}9$, the electric force was 138·57, that is, it began to rise again.

Prof. G. FORBES made a communication "*On a Magnetised Chronometer Watch.*" The watch slowed several minutes a day. He found the rate to vary with the position of the watch with respect to the north cardinal point, and also in a vertical plane. The bar of the balance was magnetised, and some screw nails. He traced the variation of rate to magnetisation of the spring, the bar, and screws. The fact that it varied with position suggested that a magnetised ship's chronometer might be made which would integrate the course and give a mean course. Messrs. E. Dent and Co. had fitted a gold spring and a platinum iridium balance to the chronometer, and rendered it non-magnetisable.

NOTICES OF BOOKS.

Botanical Micro-Chemistry, an Introduction to the Study of Vegetable Histology, prepared for the Use of Students. By V. A. POULSEN. Translated with the assistance of the Author and considerably enlarged by W. TRELEASE, Professor in the University of Wisconsin. Boston: Cassino and Co. London: Trübner and Co.

PASSING over the three prefaces to this work we come to an Introduction, in which the author points out the scope and the importance of micro-chemistry; in other words, the changes produced on organised bodies by certain reagents, as seen under the microscope. Professor Poulsen discusses firstly the chemicals to be used as reagents, and secondly the vegetable substances to be sought for and the reactions by which they are known.

The enumeration of micro-chemical reagents is very complete, especially as regards the colouring agents used for the differentiation of the tissue-systems and for the recognition of the cell-contents. Here, however, we find a peculiarity in nomenclature. The author speaks repeatedly of "fuchsin." We know that this name is applied in France and Germany, and latterly in America, to the salts of rosaniline. Now, we always protest against this name, firstly as being incapable of pronunciation by any Englishman who is not versed in the German tongue, but secondly and mainly because, like its kindred colour-names peonine and azaleine, it conveys the false idea of a proximate vegetable principle. But a couple of pages further we meet with "magenta," spoken of as if it were another substance. Surely the author, or the translator, must know that magenta is the technical English name for the salts of rosaniline, and is consequently synonymous with fuchsin!

As an appendix to this part we find an account of the best media for mounting microscopic preparations.

The second section of the work gives a good description of vegetable substances and the methods for their recognition.

The work is provided with a good index and a bibliography of micro-chemistry.

To the student of vegetable histology this book will prove a safe and welcome guide.

Year-Book of Pharmacy: Comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1st, 1882, to June 30th, 1883; with the Transactions of the British Pharmaceutical Conference at the Twentieth Annual Meeting, held at Southport, September, 1883. London: J. and A. Churchill.

THIS useful volume opens with an introductory summary of progress in materia medica, pharmacy, and chemistry. Next follow abstracts of the most important papers in connection with these subjects which have appeared in the scientific journals. Many of the paragraphs are of course not of very recent date, but they are here presented in a convenient form for reference. The solubility of lead sulphate in ammonium citrate mentioned by S. Rovera, seems a case of "re-discovery." It has been known for about 30 years.

In some cases there appears to be a difficulty in drawing the line between the departments of chemistry and pharmacy. In both we find analytical procedures. Under pharmacy figure such paragraphs as "The Adulteration of Cochineal" and the "Valuation of Commercial Extracts of Logwood," the method recommended for the detection of glucose or treacle being the addition of yeast. We should much prefer to dye comparative swatches of cloth.

The difficult question of antiseptics and disinfectants is dealt with at some length, and many interesting results are quoted. "Notes and Formulæ" includes receipts of a

very varied nature for the preparation of medicines, cements, inks, perfumes, and even blacking.

"Bibliography" is a very useful section, giving the titles of such books, pamphlets, &c., on chemistry, pharmacy, materia medica, and kindred subjects as have appeared between July 1st, 1882, and June 30th, 1883. The works on chemistry amount to 90, those in the English language being in a very decided minority. Here again we find a peculiarity of classification. The "Précis de Toxicologie" of Chappuis is placed under "Materia Medica," whilst Dragendorf's "Beitrage zur Gerichtlichen Chemie" ranks under chemistry.

The Presidential address delivered by Prof. Attfield at the meeting of the Pharmaceutical Conference deals largely with what may be called pharmaceutical legislation. The speaker advocates increased restrictions on the sale of poisons. Now, unfortunately, these substances, or at least many of them, are of frequent and important use in the arts, and there is room to fear that the proposed measures may seriously interfere with experiment and invention. This view seems to be taken by the Government, since, according to Dr. Quinlan, an "amended schedule" of poisons was sent in, and a letter from the Under Secretary replied that "the addition of these things to the schedule would interfere with the course of trade and manufactures." This is a very serious point. If the purchase, *e.g.*, of the ordinary mineral acids is to be hedged round with tedious formalities, chemical research will be almost limited to men who have already achieved a high position.

But with the proposal to place further restrictions on the sale of medicinal substances not used in the chemical arts or in scientific investigation we can cordially sympathise. Many proprietary medicines contain formidable poisons, and yet they are at present to be procured in any quantity, not merely from grocers and oilmen, but especially from the monopolising class of drapers, now so plentiful in our large towns.

CORRESPONDENCE.

ZINC IN DRINKING-WATER.

To the Editor of the Chemical News.

Sir,—My friend Mr. Heaton very properly draws attention to the occasional presence of zinc in potable water. That this metal exists in solution in some waters when kept in contact with the metal has, however, been long known, and has been the subject of repeated investigation. In the "Guy's Hospital Reports" for 1872, vol. xvii. [3rd series], p. 233, is a short paper by myself (see page 107), embodying, as I believe, all that was then known on the subject.—I am, &c.,

Thomas Stevenson.

February 27, 1884.

ZINC IN DRINKING-WATER.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlix., p. 85, you publish a note on this subject by Prof. C. W. Heaton. As Prof. Heaton states that he believes the solvent action of water on zinc not to have been observed before, may I be permitted space to make the following remarks?

In the Sixth Report of the Rivers' Pollution Commission, p. 226, in treating of the action of water upon lead, it is pointed out that certain polluted shallow well waters, containing much dissolved oxygen and but little carbonic acid, possess the property of acting continuously both on bright and tarnished lead, and that when galvanised iron pipes are substituted, the water is found to be impregnated with zinc instead of lead. The following analytical figures show the composition of a shallow well-water of this kind, which was the cause of a serious case of lead-, and subsequently of zinc-poisoning:—

Results of Analysis expressed in parts per 100,000.

Dissolved Matters.							Hardness.		
Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total combined Nitrogen.	Chlorine.	Temporary.	Permanent.	Total.
23·28	0·109	0·038	0·026	0·062	0·121	4·0	1·0	9·4	10·4

Remarks.—Clear, palatable. No nitrites. No phosphates.

100 cubic inches of this water contained in solution:—

Nitrogen	1·3409	cub. ins.
Oxygen	0·6091	,,
Carbonic acid	1·4531	,,
	3·4031	,,

The Loch Katrine water, which acts both on bright and tarnished lead, also attacks galvanised iron. The presence of zinc in water is easily recognisable by the thin white film which forms on the surface of the water, when the latter is exposed to the air. Rain-water apparently does not attack galvanised iron under ordinary circumstances, but if intended for drinking, its storage in tanks of this material is probably attended with some risk.—I am, &c.,

Percy F. Frankland.

Grove House, Pembridge Square, W.,
February 27, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Part 9.

The Elementary Composition of Certain Kinds of Wood, along with Calorimetric Experiments on their Combustibility.—E. Gottlieb.—In this elaborate paper the author gives the analysis of specimens of oak, ash, beech, hornbeam, birch, pine, and red fir, along with an account of the soils in which the respective trees had grown. The ultimate analyses of the organic matter are collected in the form of tables, which do not admit of abridgment. In the second section of the memoir the number of calories obtained by the combustion of known weights of the woods is given. The highest rank as a heat generator is assigned to *Pinus abies*, probably *Abies excelsa*, the spruce fir. The author concludes that in the combustion of wood more heat is evolved than the quantity calculated by Dulong's formula from the elementary composition.

Trichloro-quinone-chlorimide, Tri-, and Tetrachlor-quinone.—M. Andresen.—A study of the behaviour of trichloro-quinone, tetra-chloro-quinone, and trichloro-quinone-chlorimide with aniline, the properties of monochlor-dianilido-phenyl-quinonimide, a product of the reaction of the two bodies last mentioned, its behaviour with nitrous acid, alkalies, and hydrochloric acid, and the action of hydrobromic and hydriodic acid upon trichloro-quinon-chlorimide.

Di-iodo-quinone and Di-iodo-quinon-chlorimide.—R. Seifert.—A preliminary announcement.

The Real Types of Organic Compounds.—H. Kolbe.—The author considers carbonic acid as the type

of acetic acid and of the carbon acids in general; sulphuric acid as the type of the sulphones and of sulphonic acids; sulphurous acid as type of the triethyl-sulphine compounds; ammonia as type of methylamine, &c.; arsenic acid as type of kakodylic acid, and arsenious acid as type of kakodyl oxide.

Vol. xxviii., Parts 10 and 11.

Studies in Chemical Dynamics.—W. Ostwald.—A very important paper, which does not admit of useful abridgment.

Remarks on F. Salomon's Memoir on "Starch and its Transformations under the Influence of Acids."—F. Musculus.—The author points out several errors in the memoir of Salomon.

Bulletin de la Société Chimique de Paris.
Vol. xli., No. 3, February 5, 1884.

Notes on the Observations of M. Spring.—Ed. Jannettaz.—The author has not obtained any decisive evidence of crystallisation produced by pressure. As regards the production of combinations by the same agency M. Jannettaz holds that this phenomenon where it occurs is due to the enormous quantity of heat liberated by strong pressure.

Second Anhydride of Mannite.—A. Fauconnier.—The author has obtained and examined iso-mannide, an isomer of the mannide of Berthelot. He has made a particular study of its ethers.

Action of Cyanogen upon the Toluidines.—J. A. Bladin.—Gaseous cyanogen is readily absorbed by an alcoholic solution of para-toluidine, forming a crystalline mass of a basic character, which produces colourless compounds with acids. The ortho compound is obtained in an analogous manner, and is similar in its properties, but dissolves more readily in alcohol. The meta compound is also obtained in a corresponding manner. From its mother-liquors there is deposited a compound in small red crystals, which the author has not yet examined.

Die Chemische Industrie.
Vol. 7, No. 1, January, 1884.

Report of the Workmen's Insurance Commission.—The General Assembly of the Association for Promoting the Chemical Industry of Germany appointed, at its meeting in September last, to inquire into the best means of securing proper care for invalid workmen, &c., have issued their report. It was considered that a charge on every chemical manufactory at the rate of 15 marks per head of the persons employed would meet the exigencies of the case.

Processes in the Lead Chambers.—G. Lunge and P. Naef.—This paper is a further expansion of that by Dr. Lunge, recently inserted in the Chemical News.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin,
Vol. 16, No. 8.

Pyro-sulphuryl Chloride.—D. Konowalow.—MM. Heumann, Kœchlin, and Billitz have published results on this compound confirming the author's views (*Comptes Rendus*, xlv., 1284) on the cause of the deviation of its vapour-density from the law of Avogadro, and adding a hypothesis of their own, that this body undergoes a decomposition during the determination of its vapour-density. This assumption the author does not regard as justified by facts.

Substituted Pyromucic Acids.—H. B. Hill.—The author has studied the formation of bromo-pyromucic acids, of the two dibromo-succinic acids formed along with fumaric acid, and the production of dibrom-furfuran-tetra-bromide.

Violuric Acid.—M. Ceresole.—The author regards violuric acid as an iso-nitroso compound, and has effected its synthesis from hydroxylamine and alloxan.

A New Homologue of Resorcin.—F. Pfaff.—The author has obtained a compound which he names xylorcine. It crystallises in octagonal tables, perfectly transparent, fusible at 124·5° to 125° soluble in hot and cold water, in alcohol and ether, and possessing a strongly acid taste.

Examination of Fats.—Karl Zulkowsky.—Inserted in full.

Copper Sulphide in a Colloidal State.—W. Spring.—Inserted in full.

Potassium Carbonate.—E. A. Flückiger.—The author refers to a potassium carbonate which he described in 1856 in the *Schweizerischen Zeitschrift fur Pharmacie.* It was formed as an efflorescence in an open earthenware box which had contained crude potash. It formed white crystalline needles, permanent in the air; its solution in water did not precipitate magnesium sulphate. The salt, though formed from crude potash, contained neither chlorine nor sulphuric acid. He considers that it contains a pyrocarbonic acid or polycarbonic acid, $C_3O_8H_4$.

Behaviour of Carbo-trithio-hexa-bromide when Heated, and Formation of a Peculiar Colouring-Matter.—C. Hell and Fr. Urech.—If $C_2S_3Br_6$ is heated above its melting-point (125°) it takes a deep brown colour. About 180° a brown liquid, containing free bromine, distils over, and a deep blue powdery mass remains behind. If the distillate is re-distilled, it leaves more of the blue compound. This pigment is practically insoluble in water, alcohol, ether, and glacial acetic acid. It dissolves with a splendid blue colour in sulphuric acid and in phenol. The solution, if shaken up with zinc powder, turns brown. It dissolves in aniline with a brown colour, but undergoes a chemical change. Its composition is $C_9Br_4S_4,2H_2O$.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Redonda Phosphate.—What is the average composition of this mineral as shipped in large quantity, especially as regards the contents of iron? Where could I get a sample of the mineral?—T. B.

MEETINGS FOR THE WEEK

Saturday, Mar. 8.—Medical, 8.30. (Anniversary.)
Monday, Mar. 10th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
Tuesday, 11th.—Institute of Civil Engineers, 8.
—— Photographic, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
Wednesday, 12th.—Society of Arts, 8. "Water Regulation in regard to Floods, Drainage, and Transit," by Lieut.-General F. H. Rundall, R.E., C.S.I.
—— Microscopical, 8.
Thursday, 13th.—Royal, 4.30.
—— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
—— London Institution, 7.
—— Society of Arts, 8. "The Upper Thames as a Source of Water Supply," by Dr. Percy F. Frankland.
—— Royal Society Club, 6.30.
Friday, 14th.—Royal Institution, 8. "Mesmerism," by Mr. J. N. Langley, at 9.
—— Astronomical, 8.
—— Quekett Microscopical Club, 8.
Saturday, 15.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at Robert Rumney's Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1268.

NOTE ON AN OBSERVATION BY PROFESSOR HARTLEY.

By EILHARD WIEDEMANN.

PROF. HARTLEY* has found that on moistening the electrodes the spectral lines appear longer than when they are dry, and believes that the cause of this phenomenon is the lowering of the temperature of the electrodes. In support of this theory he finds that by heating the electrodes directly the lines become shorter. I believe this explanation to be not quite exact. On moistening the electrodes the discharge will produce oxyhydrogen gas, which will re-combine at some distance from the electrode and will produce then a large quantity of heat, which will increase the temperature of the metallic vapours. In heating the electrodes directly, we lower the potential that is necessary to produce a spark, so that at each discharge a smaller quantity of matter is dispersed and heated to less degree, the lines must therefore appear shorter.

Leipsig, February.

NOTES ON THE VOLUMETRIC ESTIMATION OF IRON.

By R. W. ATKINSON, B.Sc. (Lond.), F.C.S., F.I.C.

IN the analysis of an iron ore differences in the percentage of iron amounting to 1 per cent and above may frequently be observed between the results obtained by different chemists, although the numbers obtained by the same chemists may agree within one-tenth of a per cent. In many cases the practice is to refer the sample for analysis only when the results of the buyer's and the seller's chemists differ by more than 1 per cent: if the differences are less the custom is to buy upon the mean of the two figures. There may be several causes of this variation in the analyses (leaving out of consideration the question of any bias one way or the other), some tending to raise the percentage of iron, and others to diminish it. In all cases where volumetric methods are employed, the first and most important point to be considered is how to obtain the standard solution invariably of an accurately known strength, and it is from a variation in the methods employed for this end that a large amount of the variation in the results above alluded to is due. Presuming that potassic dichromate is the salt almost universally employed in England, in seems simple enough to weigh out the exact amount of salt and dissolve it in a known volume of pure distilled water. Some chemists recommend the fusion of the dichromate for the purpose of driving off completely the water entangled in the crystals; but if this be done, however carefully the heat be regulated, on dissolving in water and allowing to settle, a green deposit of chromic oxide will be found at the bottom of the flask or bottle, showing that a small amount of decomposition takes place during fusion, and that the value of the standard must be lower than the calculated value. Instead of fusing the salt it is much better to grind up the very purest crystals and to dry them in a steam-oven for several hours before weighing out. But, however the solution be made up, it is always safer to standardise it before use, a proceeding which I believe is general, though without great care it may lead to hopelessly erroneous results, as will be seen immediately.

The great difficulty in the use of salts of iron for standardising is to obtain one which will not alter in composition by keeping for two or three months. Ferrous sulphate is out of the question; and most specimens of the sulphate of iron and ammonium are liable to oxidation, though in a less degree than the ferrous sulphate. We have been fortunate enough to get from Messrs. Hopkin and Williams a sample of granulated sulphate of iron and ammonium, which, after several months' use, still gives the theoretical percentage of iron, ammonia, and sulphuric acid.

Best of all substances for standardising is absolutely pure ferric oxide, a substance, however, which is somewhat difficult to prepare of absolute purity. Besides the risk of taking up silica from glass vessels, and the difficulty of removing alkali, even when the perfectly pure ferric hydrate has been obtained, there is still the difficulty of igniting it without the risk of the reducing gases from the burner changing its composition. The ignition is best carried out in a muffle, if one is available.

In a large number of cases steel borings are now used for the purpose of standardising the dichromate solution. The exact composition of the steel is first determined: a weighed quantity is dissolved in dilute sulphuric acid, boiled, and then titrated by means of dichromate. As we are told that organic matter does not reduce potassic dichromate, it is assumed that the hydrocarbons formed during the solution of steel are equally without effect upon it, but the tabulated experiments which follow will, I think, cast some doubt upon this assumption. Three series of experiments have been made with solutions of potassic dichromate prepared on eight different occasions, in order to arrive at the true value of the solution in terms of metallic iron.

In the first column of Table I. the strength of the solutions, as indicated by the specimen of sulphate of iron and ammonium above referred to, is given. In the second column the standard of each solution is given, determined by dissolving a known weight of the steel in nitric acid, evaporating to dryness with hydrochloric acid to expel the nitric acid, dissolving the residue in hydrochloric acid, neutralising, reducing with ammonic bisulphite, diluting with boiling water, adding dilute sulphuric acid, and boiling for half-an-hour to expel all sulphurous acid. The liquid was then titrated with potassic dichromate solution. In the third column are given the numbers obtained by dissolving the same steel in dilute sulphuric acid, boiling, and titrating the solution with dichromate.

The composition of the steel (a piece of Bessemer rail) used in all the experiments (except solution F.) is given below:—

Fe	97·90
C	0·50
Si	0·08
S	0·15
P	0·09
Mn	1·50
	100·22

For facility of comparison the mean results of the experiments tabulated in Table I. are collected in Table II., and in addition, in columns 3 and 5, are given the differences between the standards obtained by solution of steel in sulphuric acid and those obtained by solution of the sulphate of iron and ammonium on the one hand, and by solution of steel in nitric acid on the other.

In the lowest row of Table II. the average values of the standards of the last five solutions, determined in each of the three ways mentioned, will be found, together with the differences between the standard found by dissolving steel in sulphuric acid, and by each of the two other methods.

* CHEMICAL NEWS, vol. xlviii., p. 195.

TABLE I.

EXPERIMENTS TO DETERMINE THE TRUE VALUE OF A SOLUTION OF POTASSIC DICHROMATE.

SULPHATE OF IRON AND AMMONIUM.

Wght. of Salt used.	Wght. of Iron.	C.c. used.	1 c.c. = Fe.
A Solution.			
(1) 1·7600	0·2657	44·9	0·005920
(2) 1·7500	0·2643	44·9	0·005880
(3) 1·5000	0·2143	38·2	0·005610
		Mean ..	0·005803
B Solution.			
(1) 1·7502	0·25003	42·4	0·005897
(2) 1·6608	0·23725	40·3	0·005887
(3) 1·5000	0·21430	36·4	0·005887
(4) 1·0000	0·14286	24·25	0·005890
		Mean ..	0·005890
C Solution.			
(1) 1·0000	0·14286	28·60	0·004995
(2) 1·0000	0·14286	28·55	0·005004
		Mean ..	0·004999
D Solution.			
(1) 1·9000	0·27143	53·95	0·005031
(2) 2·0000	0·28570	57·00	0·005013
		Mean ..	0·005022
E Solution.			
(1) 2·2998	0·32857	54·80	0·005996
(2) 1·9000	0·27143	45·35	0·005985
(3) 2·2018	0·31454	52·45	0·005997
		Mean ..	0·005993
F Solution.			
(1) 1·8998	0·27140	54·3	0·004998
(2) 2·0002	0·28570	57·0	0·005012
(3) 1·9998	0·28569	57·1	0·005003
		Mean ..	0·005004
G Solution.			
(1) 1·9008	0·27154	54·35	0·004996
(2) 1·9999	0·28570	57·20	0·004995
		Mean ..	0·004996
H Solution.			
(1) 1·9000	0·27143	45·40	0·005979
(2) 2·0000	0·28571	47·75	0·005983
(3) 1·9004	0·27148	45·40	0·005980
		Mean ..	0·005981

STEEL dissolved in HNO_3, evaporated with HCl, reduced and titrated.

Wght. of Steel.	Wght. of Iron.	C.c. used.	1 c.c. = Fe.
C Solution.			
(1) 0·2443	0·23941	47·9	0·00500
			0·00500
D Solution.			
(1) 0·2790	0·27342	54·3	0·005035
(2) 0·3535	0·34643	68·9	0·005028
		Mean ..	0·005031
E Solution.			
(1) 0·2785	0·27293	45·55	0·005992
(2) 0·3511	0·34408	57·60	0·005973
(3) 0·2936	0·28773	48·10	0·005982
(4) 0·4400	0·43120	71·90	0·006000
		Mean ..	0·005987
*F Solution.**			
(1) 0·2726	0·26715	53·4	0·005002
(2) 0·3284	0·32180	64·15	0·005016
		Mean ..	0·005009
G Solution.			
(1) 0·2794	0·27381	54·80	0·004997
(2) 0·2831	0·27744	55·55	0·004994
		Mean ..	0·004996
H Solution.			
(1) 0·3353	0·32859	54·95	0·005980
(2) 0·3333	0·32663	54·65	0·005977
		Mean ..	0·005979

STEEL dissolved in dilute H_2SO_4, boiled, and titrated.

Wght. of Steel.	Wght. of Iron	C.c. used.	1 c.c. = Fe.
A Solution.			
(1) 0·1120	0·10976	19·9	0·005515
(2) 0·1608	0·15758	28·5	0·005530
(3) 0·1688	0·16540	29·7	0·005560
(4) 0·1014	0·09940	17·9	0·005550
(5) 0·2398	0·23500	42·55	0·005520
(6) 0·2508	0·24580	44·25	0·005550
		Mean ..	0·005538
B Solution.			
(1) 0·2244	0·21990	37·6	0·005850
(2) 0·3222	0·31576	53·9	0·005860
(3) 0·2423	0·23745	40·6	0·005850
(4) 0·2513	0·24627	42·1	0·005850
		Mean ..	0·005852
C Solution.			
(1) 0·2098	0·2056	41·4	0·004966
(2) 0·1990	0·19502	39·35	0·004956
		Mean ..	0·004961
D Solution.			
(1) 0·2680	0·26264	52·65	0·004990
			0·004990
E Solution.			
(1) 0·3163	0·30997	52·10	0·005950
			0·005950
*F Solution.**			
(1) 0·2744	0·26890	54·10	0·004975
(2) 0·3250	0·31850	64·00	0·004980
		Mean ..	0·004978
G Solution.			
(1) 0·2551 Steel dissolvd. in HCl in current of CO_2.	0·24999	50·35	0·004965
(2) 0·2803	0·274694	55·20	0·004975
		Mean ..	0·004970
H Solution.			
(1) 0·3012	0·295176	49·65	0·005945
(2) 0·3532 Steel dissolvd. in HCl in current of CO_2.	0·346136	58·20	0·005947
(3) 0·3291	0·32252	54·05	0·005967
		Mean ..	0·005953

* Standardised with a different sample of steel containing Fe, 99·45 per cent; C, 0·139 per cent.

It will be observed that whilst the average strength of the solutions found by the use of sulphate of iron and ammonium (0·0053986) agrees very closely with that obtained by dissolving the steel in nitric acid and evaporating (0·0053994), both are considerably higher than the number obtained by solution of the steel in sulphuric acid (0·0053656). It follows, of course, that the differences between each of the two former and the latter are almost

TABLE II.

Abstract of Results in Table I. Averages.

No. of Solution.	Sulphate of Iron and Ammonium. I.	Difference between I. and II.	Steel dissolved in Sulphuric Acid. II.	Difference between III. and II.	Steel dissolved in Nitric Acid. III.
A	0·005803	—	0·005516	—	—
B	0·005890	0·000038	0·005852	—	—
C	0·004999	0·000038	0·004961	—	—
D	0·005022	0·000032	0·004990	0·000041	0·005031
E	0·005990	0·000040	0·005950	0·000032	0·005982
F	0·005004	0·000027	0·004977	0·000032	0·005009
G	0·004996	0·000031	0·004965	0·000031	0·004996
H	0·005981	0·000035	0·005946	0·000033	0·005979
Average D to H	0·0053986	0·0000330	0·0053656	0·0000338	0·0053994

identical, viz., 0·0000330 and 0·0000338. These numbers may appear very small, but they are not insignificant, inasmuch as the difference of a unit in the fifth decimal place with a 50-per cent ore, using half-a-gramme, means a difference of one-tenth per cent; and hence by using one or other of the above methods for standardising it is possible to have differences of more than one-third of a per cent. Too low results will therefore always be obtained when the dichromate solution is standardised by dissolving steel in dilute sulphuric acid.

The only probable explanation of the above observations seems to be that the hydrocarbons liberated during the solution of steel in sulphuric acid do possess some reducing action upon solution of potassic dichromate, though it is remarkable that the differences in Solution F seem almost as marked as in the other solutions, although in that case a mild steel was employed containing only 0·14 per cent carbon.

The practical conclusion to be drawn from the above is that if steel be used for standardising it should be treated in such a way as to destroy the hydrocarbons, that is, by solution in nitric acid and evaporation to dryness with hydrochloric acid, the residue then being further treated exactly like an iron ore.

Some points in the treatment of an iron ore for analysis may fitly be reserved for another communication.

44, Loudoun Square, Cardiff.

ON THE

USE OF LITMUS, ROSOLIC ACID, METHYL ORANGE, PHENACETOLIN, AND PHENOLPHTHALEIN AS INDICATORS.*

Part III.†

By ROBERT T. THOMSON.

The following notes are a further continuation of my former papers on the same subject:—

I. *Determination of Small Proportions of Hydrate in Prer sence of Large Quantities of the Carbonates and othe- Compounds of Sodium and Potassium.*

There are excellent processes for the determination of large proportions of hydrate in solutions which contain comparatively small quantities of the alkali metals, but in the converse case chemists are forced to fall back on methods which are open to serious objection. This state of matters can, however, be remedied by the use of a method which I have employed, and which is principally based on the neutrality of precipitated carbonate of barium to phenolphthalein, a fact which I had occasion to make known in the second part of this paper. The process consists in adding to the solution of the carbonate of sodium or potassium excess of chloride of barium solution which has been previously carefully neutralised, using phenolphthalein as indicator. A double decomposition thus occurs, carbonate of barium and chloride of sodium being produced, while the hydrate remains in solution. It is now only necessary to add a little more phenolphthalein, and titrate with standard acid, the number of c.c. consumed being calculated to hydrate of sodium or potassium, as the case may be. The whole process must be carried out *in the cold*, for reasons immediately to appear. It is clearly evident that the results will be quite as accurate whatever proportion the hydrate may bear to the carbonate, and the method would thus be useful on many occasions where the use of phenacetolin as indicator would be inadmissible, or at least would give very unsatisfactory determinations. To test the process 2 grammes of pure carbonate of sodium, prepared by igniting bicarbonate of sodium at a temperature just short of the fusion-point of the former salt, were dissolved in water, mixed with a quantity of standard caustic soda containing 0·02 grm. of pure hydrate of sodium. This mixture would represent a sample containing about 1 per cent of the hydrate. To the solution excess of chloride of barium was now added, and for three experiments 4·9, 5, and 5·1 c.c. of decinomal sulphuric acid (1 c.c.=0·004 grm. NaHO) were consumed respectively. The average of these results is exactly 0·02 grm. of hydrate of sodium, which was the proportion added.

Similar results were obtained in the determination of hydrate of potassium under the same circumstnces as those just described.

In the second part of this paper I showed that precipitated carbonate of calcium was, when boiled, neutral to phenolphthalein, and experiments were therefore made in which chloride of calcium was employed to decompose the carbonate of sodium instead of chloride of barium, the titration being necessarily accomplished in a boiling solution, or at least after it had been boiled. It was found that in every case the amount of hydrate of sodium obtained was under the truth, and at the same time the results varied from each other to an appreciable extent. It would seem that some hydrate of calcium is formed, is entangled or combines with the precipitated carbonate of calcium, and thus remains insoluble.

When the sodium carbonate was decomposed by the barium salt, and the titration accomplished in a boiling solution, the results were likewise low, though not to so considerable an extent as when the calcium compound was employed. This then is the reason for carrying out the process, from beginning to end, in a cold solution.

Having now established the accuracy of the process when hydrate and carbonate only are being dealt with, the advisability of taking into account the limitations to which

* Read before the Chemical Section of the Glasgow Philosophical Society, February 11th, 1884.

† For Parts I. and II. see Chemical News, vol. xlviii, pp. 123 and 185.

it may be subject must not be overlooked. For this purpose it is necessary to discover the influence, if any, which would be exercised by the impurities often met with in commercial carbonates of sodium and potassium. It is evident that the chlorides of these metals cannot have any effect, as they are not decomposed by the barium chloride and are neutral. The sulphates and sulphites were tested after being precipitated with barium chloride, but the full amount of hydrate was obtained. If titrated directly, one-third of the base existing in the tribasic phosphate of sodium or potassium is determined by standard acid ; but I found that the phosphate of barium precipitated was neutral to phenolphthalein, and that it did not interfere to any appreciable extent with the accuracy of the results. Half of the base existing as sulphide is estimated even after addition of the chloride of barium ; but it was found that if a few drops of hydrogen peroxide is added, and the solution allowed to stand for a few minutes, the sulphide is completely converted into sulphate, and thus rendered harmless. The only other compounds likely to be present are the silicate and aluminate of sodium or potassium. In the case of the latter compound the whole of the soda or potash will be determined, while in the silicate it was found that although barium silicate was precipitated, about 90 per cent of the base was obtained, or exactly the proportion brought out by the direct titration of the alkaline silicate. The composition of the sodium silicate adopted is that of ordinary "soluble glass" ($Na_2Si_4O_9$).

The foregoing method can also be applied to the determination of hydrate of sodium or potassium in various other compounds which give precipitates with barium chloride neutral to phenolphthalein, such as the normal sulphites and phosphates of the alkali metals. The use of indicators may be shown from an analysis of sulphite of soda. Of course sulphate, thiosulphate, and chloride are determined as usual ; but to estimate sulphite, carbonate, and hydrate or bicarbonate of sodium by methods in ordinary use is rather a tedious operation. To find the proportion of hydrate all that is now necessary is to precipitate with barium chloride, and titrate with standard acid as above described. Then, by simple titration of another portion of the sample in the cold, using phenolphthalein as indicator, the hydrate and half of the carbonate can be found ; and finally, by employment of methyl orange as indicator, and further addition of acid, the other half of the carbonate and half of the sulphite of sodium can be estimated. By simple calculations the respective proportions of these two compounds can be obtained, a result which can be accomplished in a few minutes. It must be borne in mind that if a large quantity of carbonate of sodium is in the sample, the proportion of that compound found will only be an approximation to the truth, as the end-reaction is only delicate with small proportions of carbonate of sodium. If there is no hydrate found bicarbonate of sodium can be tested for and determined by the method to be described.

II. *Determination of Bicarbonate of Sodium or Potassium in presence of the Normal Carbonate.*

The method I would propose for this rests on the same basis as that which has just been under consideration. It consists in adding to the cold solution of the sample an excess of standard caustic soda, the strength of which has been accurately tested as regards sodium hydrate by the method described above ; then adding barium chloride, and estimating the excess of hydrate of sodium employed by standard acid. This result is subtracted from the total caustic soda used, and the remainder, which has been consumed in converting the bicarbonate into normal carbonate of sodium or potassium, calculated to the first-mentioned of these salts. To put this process to the test 2 grms. of pure carbonate of sodium were mixed with 0·03 grm. of the bicarbonate, and the whole dissolved in cold water. To the mixture 5 c.c. of decinormal hydrate of sodium, then excess of chloride of barium, were added, and finally decinormal sulphuric acid, of which 1·4 c.c. were consumed in one experiment and 1·5 in another. This shows that in the first case 3·6, and in the second 3·5 c.c., of the decinormal alkali were consumed in neutralising the bicarbonate of sodium, the calculated results being equivalent to 0·03024 and 0·0294 grm. respectively. of that salt, in place of 0·03 grm. actually used.

Another test was made with 2 grms. of a sample which contained 88·6 per cent of bicarbonate of sodium. To the cold solution 25 c.c. of normal sodium hydrate were added, and, after precipitation with barium chloride, exactly 4 c.c. of normal acid were consumed. This represents 1·764 grms. of $NaHCO_3$ instead of 1·772 grms. really present.

As will be seen this method is a modification of that described by Lunge (*Journ. Soc. Chem. Industrie*, i., 57), the essential difference consisting in the use of phenolphthalein as indicator. By this means the time is saved which would otherwise be consumed in removing the carbonate of barium precipitate when the latter process is employed.

III. *The Arsenates of Sodium and Potassium, and Determination of Arsenic Acid in these Compounds.*

A series of experiments were made with normal arsenate of sodium (Na_3AsO_4) with the view of observing the behaviour of that salt with the five indicators before treated of, when titrated with standard sulphuric acid.

Arsenic acid was first prepared by oxidising 9·9 grms. of arsenious acid (As_2O_3) with nitric acid, and evaporating over a water-bath several times with addition of water, till all the nitric acid was expelled. The arsenic acid thus obtained was dissolved in water, 300 c.c. of normal caustic soda solution added, and the whole made up to 500 c.c. The caustic soda had been nearly entirely freed from carbonate by adding a slight excess of barium chloride, then removing the excess of barium salt by addition of sodium sulphate, allowing the precipitate to settle thoroughly, and syphoning off the clear fluid. For each test 50 c.c. of the arsenate solution were employed, and this quantity contained exactly 2·08 grms. of normal arsenate of sodium, which is equivalent to 0·93 grm. of soda (Na_2O) and 1·15 grms. of arsenic anhydride (As_2O_5). But to make sure that no arsenic had been lost by spirting or other means, during the oxidation and evaporation described, a determination was made by precipitation as ammonium magnesium arsenate, the weight of which showed that the solution contained the proportion of sodium arsenate stated.

Litmus.—When this indicator was employed 19·9 c.c. of normal acid were required to effect the neutralisation. After adding about two-thirds of the acid the blue colour had become purple, and onwards from that stage the blue was gradually discharged until the pure red only was observable. Owing to this gradual change in colour it is very difficult to detect the point at which the last trace of blue or purple is eliminated, and indeed this can only be done with any degree of accuracy by comparing the solution which is being titrated with an equal volume of water containing the same proportion of litmus reddened by an excess of acid.

Rosolic Acid acts in every way like litmus, the change in colour being very slow and the end-reaction very indistinct. To bring to the neutral point 19·85 c.c. of the normal sulphuric acid were required. This is equal to 0·614 of soda, or about two-thirds of that contained in the normal arsenate used, so that the mono-sodium salt (NaH_2AsO_4) may be said to be practically neutral to both rosolic acid and litmus.

Methyl Orange.—For two experiments made with methyl orange as indicator 20·0 and 20·05 c.c. were respectively consumed, the average of these being equal to 0·6207 grm. of soda, or almost exactly two-thirds of the soda present. Not the slightest change in colour was observed until the amount of acid quoted was added, and then only a slight tinge of pink was imparted to the yellow colour, so faint that without some practice it is almost impossible to detect

it without comparison with the same bulk of water coloured with a quantity of methyl orange equal to that which has been employed in the titrated solution. A few drops more of the standard acid brought out the full pink colour, so that this intensification of colour can be used in confirmation of the first result.

Phenacetolin acted in much the same manner as rosolic acid and litmus, the end-reaction being very ill-defined. To bring to the neutral point 19·9 c.c. of normal acid were consumed.

Phenolphthalein acts in an entirely different way to any of the other four indicators. It differs from litmus, rosolic acid, and phenacetolin in giving a well-defined end-reaction, and is also dissimilar to these and to methyl orange, in indicating the neutral point at a different stage of the process. In two experiments in cold solutions 10 c.c. were consumed for each, a result which is equivalent to one-third of the total soda. It is thus established that while the mono-sodium arsenate (NaH_2AsO_4) is neutral towards the four indicators just enumerated, the disodium salt (Na_2HAsO_4) is neutral to phenolphthalein. When used in a boiling solution the last-named indicator gives a sensibly higher result, as will be seen from the following table:—

TABLE I.

Results obtained in the titration of sodium arsenate.

Na_3AsO_4 used for each test .. 2·08 grms.
= Na_2O ,, ,, .. 0·93 grm.

Name of Indicator.	C.c of Normal Acid consumed.	Gramme of Na_2O found.
Litmus	19·9	0·6169
Rosolic acid..	19·85	0·6154
Methyl orange	20·0—20·05	0·6200—0·6215
Phenacetolin	19·9	0 6169
Phenolphthaiein (cold)	10·0—10·0	0·3100—0·3100
,, (hot)	10·9—11·0	0·3379—0·3410

It is evident that, on the definite difference of indication shown by methyl orange and phenolphthalein, a process for the determination of arsenic acid in commercial arseniate of soda may be founded, as I formerly showed could be done for the acids of phosphate and sulphite of sodium. All that is necessary is to dissolve 2 or 3 grms. of the sample in water, filter if necessary, then add standard acid or alkali till the neutral point is reached with methyl orange. Now boil to expel carbonic acid, cool (if the solution is kept hot a low result will be the consequence), add a little phenolphthalein, and determine with normal or half-normal hydrate of sodium. One c.c. of normal alkali will be equal to 0·115 grm. As_2O_5. To make sure that carbonate of sodium did not interfere, which it would if all carbonic acid were not expelled as described, 50 c.c. of the sodium arsenate solution used for testing the indicators were measured off, 1 grm. carbonate of sodium added, and the experiment proceeded with. Of the normal caustic soda 10 c.c. were consumed, which is equal to 1·15 grm. of As_2O_5, or exactly the proportion present. The only substance in "arseniate of soda" likely to influence the accuracy of the method is arsenite of sodium or arsenious acid, which, as I shall show presently, would tend to give somewhat high results. I may state, however, that in several samples of commercial arseniate tested by myself, I have failed to detect arsenite.

Tests were also made with potassium arsenate, but it was found that it acted in every particular in precisely the same manner as the sodium compounds.

IV. *Arsenite of Sodium and Potassium.*

For the purpose of experiment 9·9 grms. of pure arsenious anhydride (As_2O_3) were dissolved in 100 c.c. of normal caustic soda freed from carbonate, and the whole made up to half a litre with water. For each test 50 c.c. were employed, and this quantity would contain 1·3 grms. of sodium arsenite ($NaAsO_2$) or 0·31 grm. of soda (Na_2O).

Litmus.—When this indicator was used 10 c.c. of normal acid were consumed, and, although the blue colour became purple towards the end of the experiment, the end-reaction was easily recognised. The amount of soda obtained was exactly that present.

Rosolic Acid behaved in much the same way as litmus, the colour changing slowly towards the end, but the end-reaction being distinct.

Methyl Orange.—With this indicator 10 c.c. were consumed in two experiments, which give exactly the amount of soda present. The end-reaction was quite as delicate as with carbonate of sodium, thus proving that arsenious acid is neutral to methyl orange.

Phenacetolin behaves like rosolic acid and litmus.

Phenolphthalein differs from the other indicators in showing the neutral point after the addition of 9·05 c.c. in one test and 9·1 in another. This was in a cold solution, but when boiled 8·9 and 9 c.c. were respectively required. The colour in this case also slowly changed towards the end.

TABLE II.

Results obtained in the titration of sodium arsenite.

$NaAsO_2$ used for each test .. 1·30 grms.
= Na_2O ,, ,, .. 0·31 grm.

Name of Indicator.	C.c. of Normal Acid consumed.	Gramme of Na_2O obtained.
Litmus	10	0·310
Rosolic acid..	10	0·310
Methyl orange	10—10	0·310—0·310
Phenacetolin	10	0·310
Phenolphthalein (cold)	9·05—9·1	0·2805—0·2821
,, (hot)	8·9—9·0	0·2759—0·2790

With arsenite of potassium similar results to those obtained with the sodium salt were brought out.

It will be observed that arsenious acid, although neutral to methyl orange, requires a considerable quantity of soda or potash to render it neutral to phenolphthalein, and it is for this reason the presence of an arsenite in arsenate of sodium would give the proportion of arsenic acid above the truth.

In conclusion I may state that I have made experiments with the view of basing a process for the determination of boric acid in borates, on the difference of indication shown by phenolphthalein and methyl orange. These have ended in failures, owing to the extremely indistinct end-reaction with the former indicator, even when small proportions of borate are operated upon.

City Analysts' Laboratory,
138, Bath Street, Glasgow.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 6, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

IT was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (March 20).

The following certificates were read for the first time:—G. C. Bose, J. P. Battershall, W. D. Crumbie, W. J. Grey, H. G. Greenish, J. H. Wainwright.

Dr. MILLER then read a paper entitled "*Studies on Sulphonic Acids; No. I., On the Hydrolysis of Sulphonic Acids, and on the Recovery of Benzenes from their Sulphonic Acids*," by H. E. ARMSTRONG and A. K. MILLER. The authors were led to investigate the behaviour of sulphonic acids on distillation with sulphuric acid, in the course of a study of the hydrocarbons resulting from the action of dehydrating agents upon camphor, their primary object being

the separation of the 1:2:3:5 tetra-methyl-benzene. It appeared, from various considerations, probable that this body would form a highly unstable sulphonic acid. It was found on passing steam into the sulphuric acid solution of the mixtures of hydrocarbons from camphor that all the benzenes could in this way be recovered. The method consists in passing steam through the solution of sulphonic acid or sulphonate in sulphuric acid, the acid solution being heated and maintained at the temperature at which hydrolysis takes place with fair rapidity. A weight of acid was usually employed equal to that of the sulphonate taken. Apparently no decomposition of any of the benzenes takes place, and the yield of hydrocarbon may be said to be theoretical. The authors give the following list of sulphonic acids used and the temperature of initial hydrolysis:—Benzen-sulphonic acid, 175°; toluen-para-sulphonic acid, 150°; meta-xylen-sulphonic acid, 120°; ortho-xylen-sulphonic acid, 120°; para-xylen-sulphonic acid, 120°; pseudo-cumene-sulphonic acid, 115°; mesitylen-sulphonic acid, 100°; cymen-sulphonic acid, 130°; 1:2:3:5 tetra-methyl-benzen-sulphonic acid, 120; meta-methyl-isopropyl-benzen-sulphonic acid, 120°; 1:2:4 dimethyl-ethyl-benzen-sulphonic acid, 120°. From their results the authors believe that it will be possible to separate many hydrocarbons by this "fractional hydrolysis" from mixtures of their sulphonic acids. The authors give some results in which the rate of hydrolysis at different temperatures has been studied. They are about to investigate the influence of pressure on the rate of hydrolysis.

Dr. Tilden asked if there appeared to be any relation between the composition of the sulphonic acids and the temperatures at which they were decomposed.

Dr. Armstrong said that sufficient data had not yet been obtained, but apparently the simpler the constitution the less readily did decomposition take place. He also mentioned that in many cases fractional distillation completely failed as a method for purifying hydrocarbons, principally because bodies belonging to different series, but having the same boiling-point, were often present in the same mixture. By the above method this difficulty might be overcome. The excess of hot strong sulphuric acid was also advantageous in carbonising some hydrocarbons present as impurities.

The Secretary then read a paper "*On a Relation between the Critical Temperatures of Bodies, and their Thermal Expansions as Liquids*," by T. E. Thorpe and A. W. Rücker. From Van der Waals's investigations it appears that the want of similarity between the formulæ which express the expansions of liquids is due to the fact that their initial-point is in general the arbitrarily-selected temperature of melting ice. Uniformity of mathematical expression can only be attained if, in each case, the temperature is expressed, not in ordinary thermometric degrees, but as a fraction of the absolute boiling-point of the substance. It is thus possible to obtain the law of the thermal expansion of any one liquid from that of any other, if their critical temperatures be known. Mendelejeff, in a paper recently read before the Chemical Society, gave an extremely simple and accurate empirical formula for the expansion of liquids. One of the conclusions at which Van der Waals arrives is that the product of the coefficient of expansion under constant pressure into the absolute critical temperature is, at corresponding temperatures, the same for all bodies. By combining these two formulæ the authors arrive at a formula which may be expressed in words as follows:—The density of a liquid is proportional to the number obtained by subtracting its absolute temperature from its absolute critical temperature, multiplied by a constant which is the same for all substances. The values of this constant, in the case of the substances for which the necessary experimental data exist, are almost identical, and approach very closely 2. Therefore the above expression can be further simplified thus. The density of a liquid is very nearly proportional to the number obtained by subtracting its absolute temperature from twice its absolute critical temperature. If further investigation proves that the range of variations in the above constant is small, the expression already given affords a ready and valuable means of calculating the critical temperatures of bodies from observations on their expansions as liquids.

Dr. Hugo Müller then took the chair while Dr. Perkin read a communication entitled "*Remarks on the Densities of Members of Homologous Series.*" An investigation in which the author has been for some time engaged necessitated the determination of the densities of an extended series of carefully prepared products, especially the acids and ethers of the fatty series. On examining these results they exhibited a relationship to each other. The results were therefore plotted in curves, in which the numbers of carbon atoms were used as abscissæ and a scale of numbers, embracing those of the densities, as ordinates. The curves so obtained are regular, and the dots representing the experimental numbers are either on or close to the curves, and it is obvious from an inspection of the curves that the densities of the homologous acids and ethers follow a regular law.

Dr. Tilden remarked that there were singular irregularities as regards the physical properties—for instance, melting-points—in some of the homologous series.

Dr. Armstrong suggested that in the case of formic and acetic acids this might be explained by supposing that the influence of the hydrocarbon portion of the acid was small compared to that of the oxatylic portion; and, again, we had no evidence to prove that the formula of acetic acid was not more complicated than—

$$\left\{\begin{matrix}CH_3\\COOH\end{matrix}\right.$$

If a formula could be calculated for Dr. Perkin's curves i might be most valuable in discriminating isomeric acids.

Dr. Perkin said that as regards magnetic rotation, formic and acetic acids seemed to be outside the fatty acid series, which seemed to commence with propionic acid.

Mr. Farrington then read a "*Note on some Experiments made at the Munster Agricultural School to Determine the Value of Ensilage as a Milk- and Butter-producing Food.*" Two cows were fed for a week upon ensilage and 5 lbs. of meal, and for a second week upon a mixed food of carrots, beet, hay, oats. The total quantity of milk obtained with the ensilage was 433½ lbs., giving 1 lb. of butter from 33 of milk; with the ordinary food, 414½ lbs. of milk, yielding 1 lb. of butter from 34·5 of milk were obtained. The butter from the ensilage was inferior in quality. The author states that 84 lbs. of ensilage replaced 25 lbs. of hay, and that the expense of making hay and its equivalent of ensilage was equal, but that the use of ensilage effected a saving for each cow daily of 2 stones of roots and ¼ bushel of grains. The total solids and cream in the milk were estimated.

In answer to some questions of Mr. Warington, the author stated that he was unable to give the basis upon which the equivalent quantities of hay and ensilage were calculated, and did not know whether the grass was compounded of the same materials (grass, vetches, &c.) as the ensilage.

The Secretary then read a "*Note on the Behaviour* (1) *of the Nitrogen of Coal during Destructive Distillation, and* (2) *a Comparison of the Amounts of Nitrogen left in Cokes of Various Origin*," by Watson Smith. Prof. Foster in a recent paper (*Chem. Soc. Jour. Trans.*, 1883, 110) states—"I have not made any experiments on the amount of nitrogen in tar, nor am I in possession of any information on the subject. I have assumed that the quantity is relatively small." The author of the present paper has investigated the subject, having observed in 1868 that ammonia was frequently formed during the distillation of coal-tar. He has obtained the following numbers:—Nitrogen in the tar, 1·667 per cent; in crude benzene from the tar, 2·327; in "light oil," 2·186; in creosote oil, 2·005; in "red oil," 2·194: in the pitch,

1·595. The author has also estimated the amounts of nitrogen in three cokes—*a*, ordinary gas coke; *b*, Beehive metallurgical coke; *c*, a hard, compact, metallurgical coke from a Simon-Carvés oven. *a* contained 1·75 per cent, *b* 0.511 per cent, and *c* 0·384 per cent of nitrogen.

Mr. E. W. Voelcker said that in some experiments which he had recently made he had found that it was impossible to get rid of the whole of the nitrogen by carbonising such bodies as peat, charcoal, &c., even when very high temperatures were used. These results seemed to have an important bearing on the analysis of nitrogenous bodies by the soda-lime method. When manures from such substances as blood, fish guano, &c., were analysed, if any lumps formed the whole of the nitrogen could not be obtained.

Mr. Groves said that no statement was made as to where the coke came from, whether from the middle or sides of the ovens. The middle portion of the coke, being subjected to a much lower temperature than the coke at the sides, might be expected to contain more nitrogen.

"*On a hitherto unnoticed Constituent of Tobacco*," by T. J. Savery. Whilst examining some tobacco for sugar a substance was noticed in the aqueous solution which reduced Fehling's solution. This body was almost completely removed by clarification with sub-acetate of lead, and the resulting liquid was free from sugar. The author succeeded in isolating this reducing substance by precipitation with sub-acetate of lead, decomposition with sulphuretted hydrogen, &c. The substance gave a green colouration with ferric chloride, changing to red on the addition of potash. With ferrous sulphate alone no change was produced, but when this reagent was added with ammonia a dark brown colour appeared. A purer product from unmanufactured tobacco gave the same reactions, and developed a red colour with strong sulphuric acid, changing to a claret on the addition of a trace of nitric acid. A green colour was produced with either potash or ammonia. The substance precipitated hydrochlorides of quinin and cinchonin. The author concludes that the body is closely allied to caffetannic acid, and names it Tabaco-tannic acid. No analyses are given.

The Society then adjourned to March 20, when a ballot for the election of Fellows will be held, and a "Note on the Preparation of Marsh-Gas," by Dr. Gladstone and Mr. Tribe, will be read.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, March 8, 1884.

Prof. F. Guthrie, President, in the Chair.

Lord Rayleigh read a paper "*On the Electro-Chemical Equivalent of Silver*." The determination was made by a method described to the last meeting of the British Association at Southampton, which consists in using two fixed coils and a movable coil suspended between these from one end of a balanced beam. These coils are in circuit with the current and voltameter. The current is reversed in the fixed coils at intervals of five minutes, and the weight required to bring the balance even is noted. The calculation of the effect by this method is independent of the precise measurement of the coils. Two or more silver voltameters were in circuit, nitrate of silver being the solution used. Careful precautions of various kinds were taken, and the result was that unit C.G.S. current deposits $1{\cdot}118 \times 10^{-2}$. It follows that 1 ampere will deposit 4·025 grammes of silver per hour.

Lord Rayleigh also read a paper "*On the Absolute Electromotive Force of Clark's Cell*." Experiments made at the Cavendish Laboratory gave the electromotive force of this cell as 1·453 volts. The accepted value is 1·457 volts. If the B.A. unit (as Lord Rayleigh believes) is about 0·9867 of a true ohm, the result 1·453 becomes 1·434 volts.

Lord Rayleigh also mentioned that he had been making experiments on the rotation of the plane of polarised light in bisulphide of carbon, and obtained a result agreeing more nearly with Gordon's than Becquerel's.

Profs. Guthrie and Ayrton spoke on the papers, the former eliciting the reply that electro-corrosion was less satisfactory than electro-deposition for determining the equivalent; and the latter that silver was better than copper for accurate results in the voltameter.

Mr. Shelford Bidwell, M.A., read a paper "*On some Experiments Illustrating an Explanation of Hall's Phenomenon*." By these experiments Mr. Bidwell sought to explain Hall's effect through a combination of mechanical stress and the well-known Peltier effect, on the thin metal plate which is placed between the poles of the magnet. He repeated many of the experiments, and showed how he had obtained the same results as Hall, except in the case of aluminium, which he found to be 1+, like iron, whereas Hall made it −. Mr. Bidwell reversed the effect by cutting two slits in the strip of metal, thereby altering the stress on it. Righi's effect was also explained on the same grounds.

Mr. Walter Browne said that difference in the quality of the aluminium might explain the anomaly with this metal.

Prof. Perry criticised the explanation of the slitted plate, and Prof. G. C Foster suggested that results in absolute measure should be got.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, March 3rd, 1884.

Sir Frederick Pollock, Bart., M.A., Manager and Vice-President, in the Chair.

The following were elected Members of the Royal Institution :—Major-Gen. W. H. Beynon, F. W. Blunt, J. G. Bristow, M.A., Mrs. R. Brudenell Carter, Mrs. J. T. Clover, F. M. Gowan, W. Hooper, J. C. Medd, R. Muir, B. M. Power, Mrs. William Crookes, P. Donovan, J.P., L. H. Edmunds, B.A., Miss J. L. Reynolds, S. H. Salt, G. N. Strawbridge, F.Z.S.

Three Candidates for Membership were proposed for election.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

January 23rd, 1884.

Mr. J. J. Coleman read a paper describing experiments he had made on the heat-conducting power of substances available for the insulating walls of ice-houses and other purposes of a similar character.

Tin boxes, of about 1 cubic foot capacity, were placed inside tin boxes of larger capacity, so as to allow of a uniform space of 4 inches wide between the outer surface of the inner box and the inside of the outer box, which space was filled with the material to be tested. A number of such boxes were arranged in a room kept by a stove at a uniform temperature of 60° Fahrenheit, and a similar number in a room of 100° F. temperature, the ice melted in twenty-four hours being from time to time drawn off and measured after the principle of the Lavoisier calorimeter. The first series of experiments in a room of 60° F. gave the following figures as the conducting power for heat, viz. :—

1. Silicate cotton	100
2. Hair felt	117
3. Wood charcoal	120
4. Wood shavings	125
5. Gas works breeze (coke dust)	230
6. Air spaces of 1 in. alternated with wood 1 in...	280

A second set of experiments in a room of 100° F. gave as follows:—

1. Silicate cotton	100
2. Cotton wool	122
3. Sheeps' wool	136
4. Infusorial earth	136
5. Wood charcoal	160
6. Sawdust	163

In this room the quantity of ice melted per square foot of superficies per twenty-four hours was about 1 pound avoirdupois for an insulation of charcoal 4 ins. thick.

Mr. COLEMAN also exhibited a Discontinuous Thermoscope, or Thermometer, he had invented, composed of a number of tube bottles arranged in a row in a wooden frame, the liquid contents of which became frozen successively as the temperature lowered, commencing with an olefine (paraffin) solidifying at 100° F., the series consisting of olefines until 32° is reached, when the series is continued to 40° below zero with mixtures of glycerin and water.

At the meeting held on February 23rd the triennial "Graham Lecture" was communicated to the Society by R. ANGUS SMITH, LL.D., F.R.S, and consisted chiefly of extracts from unpublished private letters of Thomas Graham to members of his family and friends, which were of a most interesting character, and are to form the basis of a memoir to be published together with a synopsis of Graham's work.

CORRESPONDENCE.

CHLOROPHYLL.

To the Editor of the Chemical News.

SIR,—In the *Journal of the Chemical Society* for February is an interesting paper by Dr. A. Tschirch on the "Preparation of Pure Chlorophyll," in which he lays claim to the discovery that chlorophyll can be generated from the oxidised product (chlorophyllan—acid chlorophyll) by the action of zinc-dust on the alcoholic solution at the heat of the water-bath. From the spectroscopic and other characters he says:—"I regard this pure chlorophyll as identical with the chlorophyll of living plants, and reserve to myself the right of examining it further."—*Trans.*, vol. xlv., p. 60.

If Dr. Tschirch will turn to the CHEMICAL NEWS, vol. xxxviii., p. 168, he will find a "Note on Chlorophyll" by Mr. A. H. Church, in which the above-mentioned process for obtaining that body from chlorophyllan by the action of zinc-dust at the temperature of the steam-oven, is described. I do not know whether Mr. Church is continuing his investigation of the green colouring matter of leaves, but evidently, in face of the above anticipation, Dr. Tschirch cannot reserve to himself the *right* of examining this substance to the exclusion of other observers.—I am, &c.,

R. W. ATKINSON.

44, Loudoun Square, Cardiff,
March 6, 1884.

SCIENTIFIC BIGOTRY.

To the Editor of the Chemical News.

SIR,—My friend Prof. Charles A. Joy, lately of Columbia College, New York, and temporarily residing in Tours, France, has sent me by mail a copy of a lecture on Organic Chemistry which deserves to be regarded as a veritable literary curiosity. The lecture in question was delivered as an inaugural discourse at the opening of the School of Medicine and Pharmacy at Tours, on the 29th of November, 1883, by E. Grandin, Professor of Chemistry and Toxicology. The lecture is entitled "La chimie organique moderne," and was published in three issues of the local newspaper *L'Union Liberale* in December, 1883.

The author of this lecture treats of the growth and development of modern organic chemistry and accomplishes the extraordinary feat of wholly ignoring German contributions to chemistry. With a single exception not a German chemist is named throughout the entire lecture, the exception being a casual reference to Bunsen in connection with cacodyle. Sweden, England, Belgium, Italy are fairly represented, but Germany is a *terra incognita*. The credit of accomplishing the first synthesis of organic bodies naturally occurring in the vegetable and animal worlds is given to M. Berthelot. Germany is indeed mentioned, but only in this wise:—"La théorie atomique est enseignée maintenant à peu près partout, en Allemagne, en Angleterre, en Italie, en France, ou elle est brillamment représentée par MM. Kekulé, Odling, Cannizaro, et Wurtz." In this sentence Kekulé is made to serve as the representative chemist of Germany!

One looks in vain for the names of Liebig, Wöhler, Hofmann, Kolbe, Baeyer, and the rest.

Professor Grandin needs to be reminded of that notable saying of Sir Humphry Davy—"Science, like that nature to which it belongs, is neither limited by time nor space; it belongs to the world, and is of no country and of no age."—(Davy's speech as President of the Royal Society when presenting the Copley Medal to François Arago).

It is to be hoped that the bigotry exhibited in this lecture is confined to very few teachers in France; should it be otherwise, alas! for the future of chemistry in *la belle France*.—I am, &c.,

H. CARRINGTON BOLTON.

Trinity College, Hartford, U.S.A.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 1, January 7, 1884.

Action exerted upon Polarised Light by Solutions of Cellulose in Schweitzer's Reagent.—A. Levallois.—All these solutions deflect the plane of polarisation strongly to the left. The tint of Schweitzer's solution is reduced when it is charged with cellulose.

The Combination-heat of Soluble Fluorides and the Law of Thermic Substitution-Constants.—D. Tommasi.—The calories of combination given recently by M. Guntz for certain fluorides are identical with those predicted in accordance with the author's law of thermic constants.

New Sulpho-salts derived from Phosphorus Trisulphide.—G. Lemoine.—The author had formerly obtained from phosphorus sesqui-sulphide, certain salts, the sulphoxy-phosphites, which may be considered as derivatives of a sulphuretted phosphorus acid, $POS_{2n}HO$. Analogous compounds may be obtained in a more direct manner from phosphorus trisulphide, which, under the influence of water tends to form phosphorous acid and hydrogen sulphide. By the action of soda in different proportions and by that of ammonium hydrosulphide, the author has obtained a series of compounds for which no names are proposed.

No. 2, January 14, 1884.

Formation-heat of the Fluorides.—M. Berthelot.—The author maintains that M. Tommasi has contributed nothing either to the especial question of the fluorides or

to the general question of thermic constants. He has made no experiments, and as to prevision he has confined himself to appropriate literally laws known thirty years ago, the law of Andrews and the law of Favre and Silbermann.

Generalisation and Rigorously Mechanical Demonstration of the Formula of Joule.—A. Ledieu.—A mathematical paper, not capable of useful abstraction.

New Method of Determining the Magnetic Declination with the Induction Compass.—M. Wild.—The author describes his process at length with the view of showing that it has a real advantage as compared with the old method.

Observation of Telluric Currents.—M. Larroque.—The intensity of the earth-current undergoes secondary fluctuations depending on the degree of moisture and on the temperature of the portion of earth which enters into the circuit.

Determination of the Combustion-heat of Certain Acetones and of Two Ethers of Carbonic Acid.—W. Longuinine.—For diethyl-ketone the mean heat evolved is 8569 cals. per grm. of the substance burnt, and for 1 mol. in grms. 736,934 cals. For dipropyl-ketone the mean values are 9244·5 cals. per grm. and 1,053,873 per mol.; for di-iso-propyl-ketone, 9172·4 cals. per grm. and 1,045,654 cals. per mol.; for methyl-hexyl-ketone, 9467·1 cals. per grm. and 1,211,789 cals. per mol. Hence there is a confirmation of the general rule that isomers of the same chemical function liberate in their combustion approximately the same quantities of heat. Methyl-carbonic ether gives 3774·34 cals. per grm. and 339,691 cals. per mol. Ethyl-carbonic ether gives 5442·8 cals. per grm. and 642,250 per mol.

The Phenomena of Dissociation.—M. Isambert.—A mathematical paper, not suitable for abridgment.

Preparation of Pure Chromium Sesqui-sulphate.—H. Baubigny.—The author takes as his starting-point a hydrate, obtained by treating purified potassium bichromate with a current of sulphuretted hydrogen, applying heat, or boiling after the treatment. The hydrate is first washed in the cold, and is then suspended in boiling water, fresh portions of which are applied until the filtrate no longer blackens a few drops of silver nitrate. Traces of alkali may be detected, if present, by igniting in the oxidising atmosphere of a muffle, and moistening the cold residue with a little pure dilute nitric acid. The presence of alkali is shown by the yellow tint of the liquid.

The Density of Liquid Oxygen.—M. Menge.—The author criticises the method of M. Wroblewski (*Comptes Rendus*, July 16, 1883), and contends that the exact specific gravity of liquid oxygen has still to be determined.

Ferric Ethylate and Colloidal Ferric Hydrate.—E. Grimaux.—If a molecule of ferric chloride dissolved in absolute alcohol is allowed to react upon 6 mols. of sodium ethylate, there is formed at once a precipitate of sodium chloride and a deep brown limpid solution of ferric ethylate, containing all the iron. If this solution is poured into an excess of water, there is obtained a clear liquid presenting the characters of the solutions of colloidal ferric hydrate described by Graham.

A Silicated Manganese Chloride.—A. Gorgeu.—If a current of hydrogen saturated with watery vapour is allowed to act at a cherry-red heat upon a mixture of 20 grms. pure manganese chloride and 1 grm. precipitated silica, there are obtained rhodonite, tephroite, and a silicated chloride.

The Influence of "Plastering" upon the Composition and the Chemical Characters of Wine.—L. Magnier de la Source.—The author fermented two equal and homogeneous portions of one and the same kind of grape, adding to the one 100 grms. pure calcium sulphate, and leaving the other without any addition. He found the alcohol and the grape-sugar in the two portions approximately identical. The total solids were increased by plastering from 23·30 to 27·30 grms.; the cream of tartar was entirely removed, the total acidity considerably increased, and especially the sulphuric acid. Plastering decomposes, not merely the potassium bitartrate, but also the neutral organic compounds of potassium, which exist in ripe grapes in a very notable proportion.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. 16, No. 8.

Further Observations on the Behaviour of the Carbon Thio-bromides.—C. Hell and Fr. Urech.—Further researches on carbo-trithio-hexa-bromide and CS_2Br_4.

The Imines.—A. Ladenburg.—Not adapted for abridgment.

Peptone.—A. Pœhl.—In this extensive memoir the author shows that the conversion of albumen into peptone is not accompanied by any change in its optical rotatory power, nor by any chemical change in the albumen molecule. He holds that the transformation depends on a gelatinising process analogous to those which we observe in hydrated silicic acid.

Different Modifications of Silver Bromide and Chloride.—H. W. Vogel.—This important paper cannot be usefully abstracted without the accompanying diagrams.

Certain Constituents of the Distillate of Wine.—S. Kiticsán.—In all the samples examined, ammonia has been found to an extent admitting of quantitative determination. Formic acid is frequently but not invariably present. Wartha's method for the detection of sulphurous acid in wine is not trustworthy, as silver nitrate gives a precipitate in wines which are absolutely free from sulphurous acid.

Mono-sulpho-pyridic Acid.—O. Fischer and C. Riemerschmid.—An account of the properties of this acid, of β-pyridine-dibromide, and of its platinum salt. The ease with which the sulpho-group of sulpho-pyridic acid is displaced by bromine is remarkable.

A Correction.—R. Andreasch.—The author points out an error in a former paper.

The Ptomaines.—L. Brieger.—The author holds that the physiological action of organic substances depends, not merely on their chemical constitution, but more or less on the number of the atoms of carbon present in the molecule.

Basic Products of Putrefaction.—E. and H. Salkowski.—The author gives for these bases the general formula $C_n H_{2n+1}NO_2$.

Decomposition of Water by the Non-metallic Elements.—C. Z. Cross and A. F. Higgin.—The authors prove experimentally that water at a boiling heat is decomposed by sulphur. Arsenic behaves in a similar manner, with the formation of arsenic hydride and arsenious acid.

The Reaction of the Acid Amides upon the Aromatic Amine Bases.—W. Kelbe.—The author finds that the acid amides if heated with aromatic bases form acid anilides.

The Behaviour of Nascent Hydrogen with Oxygen Gas.—Moritz Traube.—The author concludes that palladium hydride does not yield nascent hydrogen, that nascent hydrogen does not activate oxygen, and living tissues do not evolve hydrogen. The activating action of palladium hydride depends on the formation of hydrogen peroxide.

Journal de Pharmacie et de Chemie. Tome ix., February, 1884.

The State of Arsenic in Mineral Waters.—J. Lefort.—In the bicarbonic, sulphuric, and chloridic waters

arsenic is present in its highest stage of oxidation. In the waters containing hydrogen sulphide it is present as arsenious acid.

Analysis of the Red Spring of Zacaune (Tarn).—MM. Soubeiran and Massol.—This water presents no feature of chemical interest.

Examination of Certain Extracts of Cinchona, Belladonna, &c.—M. Lepage.—The author finds these extracts inferior to the officinal standard, and advises pharmacists either to prepare their own extracts, or to submit the samples obtained to a thorough examination.

Formation of Acetylene at the Expense of Iodoform.—P. Cazeneuve.—Already noticed.

New Researches on the Watering of Milk.—Dr. Sambuc.—For detecting the adulteration of milk with water the author, after pointing out the fallacious character of the results obtained with the lacto-densimeter, proceeds as follows:—Heat the milk to from 40° to 50°; add per 150 c.c. 2 c.c. of an alcoholic solution of tartaric acid prepared with alcohol at 85 per cent, and having the specific gravity 1·030 to 1·032. Remove from the fire, and stir with a small broom of osiers, upon which there forms a spongy clot, which entangles the butter. Strain through fine linen, pour the serum into a test-glass, and let it cool. When the temperature has fallen to 15° take its density with any sensitive hydrometer. The lowest specific gravity of the serum of genuine milk is 1·027.

Detection of Tartar Emetic in Syrup of Ipecacuanha.—M. Yvon.—The author takes 5 to 6 c.c. of the sample, adds 5 to 6 drops of hydrochloric acid, dilutes with an equal volume of water, and adds a few drops of a saturated solution of potassium iodide. If tartar emetic is present there is formed immediately a yellow precipitate of antimony iodide.

Artificial Wine.—M. Yvon.—An "industrial" is circulating the following receipt:—In a cask of 114 litres put 8 to 10 kilos. dry raisins, 10 to 14 kilos. glucose stirred up in a little water, and 1 litre of vinegar; add 1 litre of "*odorous mixture*," and 400 grms. of beer yeast. Fill up the cask with water including 6 to 8 litres boiling water, so as to raise the whole to the proper heat for fermentation. When this process is complete, colour it as desired with the accompanying "*powder*." This powder consists of magenta tailings (!), whilst the odorous mixture is a solution of tannin and tartaric acid in water flavoured with an artificial essence.

The Weight of Drops.—M. Boymond.—A paper of purely pharmaceutical interest.

Cholera, Typhoid, and Splenic Fever among the Copper-smiths of Willedieu.—M. Rochefontaine.—The author shows that, contrary to the opinion of M. Burq, copper affords no protection against zymotic diseases.

Action of Bromine on Pilocarpine.—M. Chastaing.—Already noticed.

The Artificial Production of Crystals of Gypsum.—A. Lacroix.—The author describes in detail the method by which he has obtained these crystals.

The Fusibility of the Nitrates.—M. Maumené.—From the *Comptes Rendus*.

The Artificial Production of Manganiferous Garnet.—A. Gorgeu.—From the *Comptes Rendus*.

Accidental Formation of Crystals of Cerusite on Roman Coins.—A. Lacroix.—The coins in question were composed of an alloy of copper with lead and a little tin. Some of them were coated with crystals of cerusite accompanied by a few cubes of cuprite, whilst others were encrusted with azurite, malachite, or cuprite.

Royal Institution.—Mr. Matthew Arnold will probably give a discourse on "Emerson" on Friday Evening, March 21, instead of Mr. Walter Besant, who will give his discourse on "The Art of Fiction" after Easter.

MISCELLANEOUS.

The Technological Museum, Sydney.—A superb collection of slabs of Continental Marbles was yesterday (Jan. 25) added to the Technological Museum. The slabs are uniformly 20 inches square and 1 inch thick, and are polished on one face, and on this a short description of them are to be found, the letters being cut into the slabs and gilt, producing a fine effect. These marbles are from the most celebrated quarries in Germany, Austria, Italy, France, and Belgium, and all the specimens are so handsome that it is difficult to particularise. It is proposed to line the pillars and to inlay a portion of the walls of the Museum with them. The collection of 6-inch cubes of building stones already in the Museum has also been supplemented by a number of cubes of limestone, sandstone, granite, lava, &c., from various localities in Europe. Several of these stones have been employed in the construction of the world-renowned Cathedral of Cologne, which has taken six centuries to complete. Mechanical engineers and others will be interested to learn that during the present week the walls, pillars, &c., of the Museum have been adorned with over 40 large framed photographs of machinery constructed by Messrs. Robert Daglish & Co., of St. Helens, Lancashire. Much of this machinery has been specially constructed for Colonial requirements, and includes stamper batteries, amalgamators, and miscellaneous gold mining machinery, copper ore mining machinery, appliances used in grinding, smoothing, and polishing plate-glass, miscellaneous chemical plant, including complete machinery for the manufacture of soda from sea-salt, steam cranes, hoists, &c., large boilers, blowing, winding, pumping engines, &c. A complete series of coloured maps and plans to illustrate the geology of Belgium has just been received from the Royal Museum at Brussels, and will be displayed in the course of the next few days.—*Sydney Morning Herald*, Jan 26.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Estimation of Ferrous and Ferric Oxide.—I want to estimate FeO and Fe_2O_3 in some serpentines. I conclude this HF method is the best. Is not Oudeman's method ($Na_2S_2O_3+CuSO_4+KCNS$) more expeditious than $K_2Cr_2O_7$?—A. P. S.

MEETINGS FOR THE WEEK

MONDAY, Mar. 17th.—Medical, 8.30.
—— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
TUESDAY, 18th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
—— Society of Arts, 8. "Borneo," by B. Francis Cobb.
WEDNESDAY, 19th.—Society of Arts, 8. "The Elephant in Freedom and Captivity," by G. P. Sanderson.
—— Meteorological, 7.
—— Geological, 8.
THURSDAY, 20th.—Royal, 4.30.
—— Philosophical Club, 6.30
—— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
—— Chemical, 8. Ballot for the Election of Fellows. "Note on the Preparation of Marsh-Gas," by Dr. Gladstone, F.R.S., and A. Tribe. "On the Action of Dibrom-α-Naphthol upon Amines," by R. Meldola.
FRIDAY, 21st.—Royal Institution, 8. "Emerson," by Mr. Matthew Arnold, at 9.
SATURDAY, 22nd.—Royal Institution, 3. "Photographic Action," by Capt. Abney.
—— Physical, 3. "On Hall's Phenomena," by Prof. S. P. Thompson, D.Sc., and Colman C. Starling, and also by H. Tomlinson; "On some Propositions in Electro-magnetics," by Prof. S. P. Thompson, D.Sc., and W. M. Moorsom.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1269.

ON A

CONVENIENT MODIFICATION OF McLEOD'S METHOD FOR THE FORMATION OF CUPROUS ACETYLIDE.

By G. STILLINGFLEET JOHNSON, King's College, London.

Having been in the habit of preparing cuprous acetylide for Professor Bloxam for some years past by McLeod's method, *i.e.*, by passing the products of combustion of air in coal-gas into an ammoniacal solution of cuprous hydrate obtained by adding excess of ammonia to a solution of cuprous chloride in hydrochloric acid, it always appeared to me that the most troublesome and unsatisfactory part of the process was the production of the cuprous chloride, and the large amount of cuprous chloride converted into cupric hydrate, instead of into cuprous acetylide, after the addition of the ammonia to the cuprous solution.

To avoid these difficulties, Professor Bloxam suggested to produce an ammoniacal solution of cuprous hydrate by the reducing action of glucose upon ammoniacal cupric sulphate. Acting upon this suggestion, I now employ the following apparatus which is simple, economical and easily worked.

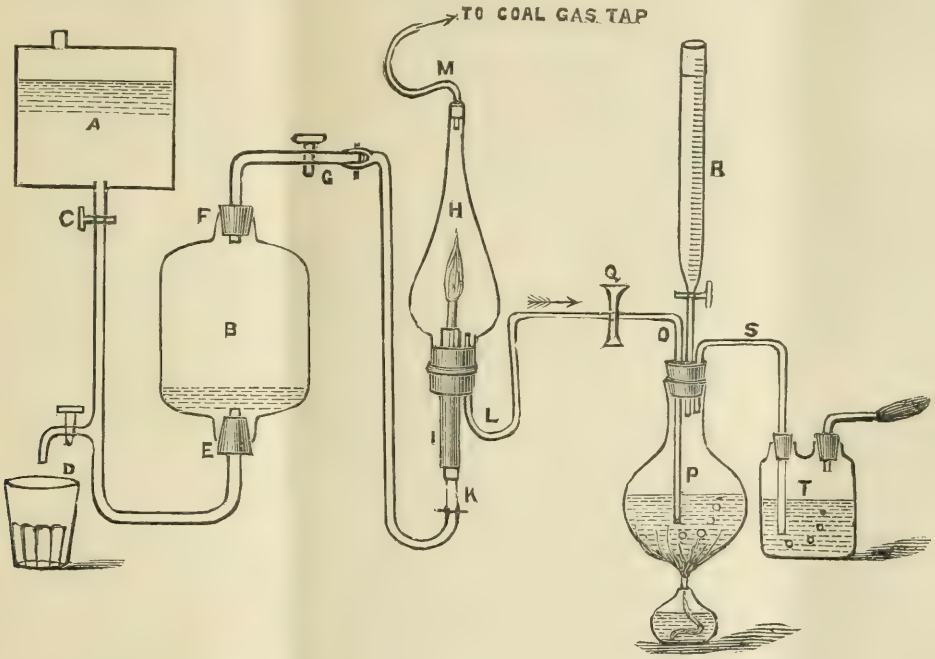
The stream of air is produced by the pressure of water in the metal reservoir, A, upon the air in the glass gas-holder, B. Now, as this part of the apparatus has been found, not only by myself, but also by many others in King's College, an extremely useful arrangement for storing gases over water without danger of contamination with the gases of the atmosphere, I will first describe the manner in which it is worked.

Suppose the reservoir A to be full of water, B to be full of air, and the taps, C, D, and G, all closed. It is desired to fill B with a certain gas, *e.g.*, oxygen. The taps G and C are opened, when the water contained in A flows into B, displacing the air it contained through the tap G. As soon as B is full of water, the tap C is closed. Now, on connecting G with the apparatus containing or evolving oxygen gas, and opening the tap D, the water in B flows out through D, whilst oxygen is drawn into the gas-holder, B, by a kind of aspiration. When B is full, the taps D and G are closed, and so long as C is also closed, there is no possibility of communication of the gas in B with the atmosphere. By opening C, we subject the gas in B to the pressure of the water in A, by which pressure it may be expelled with whatever rapidity we wish through the tap G. In my apparatus the gas-holder, B, is capable of holding about 12 litres of gas.

The special advantage of this apparatus for supplying the air to be burnt in coal-gas is the ease with which the rapidity of the current of air may be regulated by means of the tap, G, since oscillations of pressure are very apt to extinguish the flame.

The second part of the apparatus, in which the acetylene is produced, is figured and described in Professor Bloxam's work, "Chemistry: Inorganic and Organic, with Experiments"; 5th Edition, p. 93. I will quote his description of the diagram:—

"An adapter (H) is connected at its narrow end with



the pipe (M) supplying coal-gas. The wider opening is closed by a bung with two holes, one of which receives a piece of brass tube (I) about 3 quarters of an inch wide and 7 inches long, and in the other is inserted a glass tube (L), which conducts the gas to the absorbing apparatus. The lower opening of the brass tube (I) is closed with a cork, through which passes the glass tube (K), connected with a gas-holder containing atmospheric air."

The air in H being expelled by coal-gas, which is ignited at the orifice of the brass tube, I, the tube, K, delivering air from the gas-holder, B, is thrust up through the tube I into H, where the jet of air remains burning in the coal-gas.

It now only remains to describe the *Absorbing Apparatus* intended to fix the acetylene as cuprous acetylide.

The tube, L, is now delivering coal-gas, charged more or

less with acetylene, one of the products of the combustion going on in H. This tube, L, is connected by rubber tubing with another glass tube, O, passing nearly to the bottom of the flask, P, through one of three holes in its cork. A strong screw clip, Q, closes the connector on O from the atmosphere. The flask, P, contains at first a strongly ammoniacal solution of cupric sulphate. The clip, Q, being closed, the contents of the flask, P, are raised to the boiling-point, the ammonia evolved being absorbed by water in the bottle, T, into which it is conducted by the tube, S, provided with a Bunsen's valve with a *longitudinal* slit, to prevent regurgitation. When the ammoniacal cupric solution quite boils, a solution of glucose is dropped in from the burette, R, and the boiling continued, till the solution is quite colourless. The clip, Q, is then opened, and the connector slipped on to L, when the coal-gas and acetylene enter the flask, and the cuprous acetylide is precipitated as usual.

Should any air accidentally enter the flask, P, at any time before the copper is completely converted into acetylide, the clip, Q, may be again closed, the contents of the flask once more boiled (with addition of more glucose from the burette if necessary) and the blue cupric hydrate again reduced to the cuprous condition, after which Q is opened and the acetylene allowed to enter as before.

If the pressure of the coal-gas be insufficient to force it through the Bunsen's valve, the tube S may be removed, and a simple glass tube, bent once at right angles, substituted, at the orifice of which the escaping gas may be burned.

By the adoption of the above method, the necessity for first making a quantity of cuprous chloride is quite obviated, and the *whole of the copper* introduced into the flask, P, may, with certainty, be converted into cuprous acetylide without the trouble of removing it, introducing fresh charges, &c.; the reduction of any cupric hydrate accidentally produced being readily effected, as I have described, without disturbing the apparatus in any way.

March 9th, 1884.

RESEARCHES IN SPECTRUM PHOTOGRAPHY IN RELATION TO NEW METHODS OF QUANTITATIVE CHEMICAL ANALYSIS.*

PART II.

By W. N. HARTLEY, F.R.S.E., &c.,
Professor of Chemistry, Royal College of Science, Dublin.

THIS paper includes an introduction recording the methods which have been proposed by different authors for the quantitative estimation of various metallic elements. An account is then given of the length and strength of metallic lines in solutions of definite strength. Under given conditions each solution emits a characteristic spectrum. In the case of magnesium, a minute description is given of the spectra presented by various solutions containing from 1 per cent to 0·00000001 per cent of the metal, but in the case of other elements tabular descriptions of the spectra of solutions containing 1, 0·1, and 0·01, in some instances 0·001, of metal are given, together with carefully drawn maps. The substances thus treated of are magnesium, zinc, cadmium, aluminium, indium, thallium, copper, silver, mercury, tin, lead, tellurium, arsenic, antimony, and bismuth.

The sensitiveness of the spectrum reaction is practically unlimited when applied to magnesium compounds dissolved in water, since it was shown that with a given length of spark $\frac{1}{10000000}$ of a milligrm. could easily be detected; when, however, the strength of spark was greatly increased, but the striking distance between the electrodes left unaltered, the sensitiveness was increased ten thousand-fold. In point of fact, one part of magnesium was detected in 10,000,000,000 parts of water, the lines seen under these circumstances being those with wave-lengths 2801·6 and 2794·1. The spectrum reaction of arsenic is the weakest, those of antimony and tellurium are also weak, while that of bismuth is not strong. In fact it is noticeable that the more strongly basic elements are those with the most persistent lines.

Evidence is afforded in the case of the aluminium spectrum that it is not invariably the longest orstrongest line which is the most persistent. The line with wave-length 3584·4 is both longer and stronger than a pair of lines adjacent thereto with wave-lengths 3612·4 and 3601·1, but whereas the first is not seen in solutions containing 0·1 per cent of aluminium, the pair are still visible in solutions containing 0·01 per cent. Under certain conditions this single line appears the longest in the whole spectrum, whereas otherwise, and under most circumstances, the lines with wave-lengths 3960·9 and 3943·4 are longest.

As a rule, even the longest lines are shortened by great dilution of the solutions, but there is a pair of lines in the spectrum of copper with wave-lengths 3273·2 and 3246·9 which become greatly attenuated, yet nevertheless remain long lines till they finally disappear.

It is shown by one or two examples how the tables of spectra and accompanying maps may be employed in rendering quantitative results. The special applications of this method it is proposed to describe in a further communication.

* Abstract of a Paper read before the Royal Society, March 13, 1884.

ON THE PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

BY a mode of investigation I have been recently adopting through which information is furnished of the precise nature of a carbohydrate existing in a product, I have been able to recognise and follow changes which have hitherto escaped observation, and have thus been afforded the opportunity of acquiring new knowledge regarding the physiology of the carbohydrates in the animal system.

In an "Introductory Note" presented to the Roya Society in April last (*Proc. Roy. Soc.*, vol. 35, pp. 145 to 147) I gave a summarised representation of the main points that had been disclosed, and stated that I proposed to deal with the subject in detail in a series of communications.

In this communication, which constitutes the first contribution, I purpose dealing with the changes undergone by the carbohydrates in their progress after ingestion into the portal blood. When I first became aware of the significance of the information which was being revealed by the method of investigation I was pursuing, I was working at the changes occurring within the system, and more especially in connexion with the liver; but seeing that the matter was presenting itself under a perfectly new light, it appeared to me advisable that the investigation should be carried to the commencing point at which the carbohydrates come into relation with the animal system, viz., the alimentary canal. I therefore started upon a systematic inquiry into the changes undergone by the four chief carbohydrates of our food—grape sugar, cane sugar, lactin, and starch—in their passage towards absorption and arrival within the portal system of vessels. This inquiry has resulted, not only in new knowledge being supplied, but in confirmation being given to the knowledge that had been acquired regarding the phenomena occurring in other parts of the system. By thus beginning with the study of the phenomena at the starting point, or the point where the carbohydrates first come into relation with the animal system, important help has been afforded, and al

* A Paper read before the Royal Society, Dec. 20th, 1883.

the information obtained stands in harmony, the one part with another, and conspires to show that the changes occurring in the principles belonging to the carbohydrate group proceed exactly in the reverse direction of that which has been generally supposed.

The means by which the truths to be adduced have been disclosed have consisted in the employment of extended measures for discriminating the precise nature of a carbohydrate having to be dealt with, and the application of the method of quantitative determination with the ammoniated cupric test which I introduced a few years ago (*Proc. Roy. Soc.*, vol. 28, pp. 260 and 520). Without the aid of this test I am quite satisfied I could not have attained the knowledge that has been acquired. One step has led on to another, and it has been by a gradual process that the matter as it has now to be put forward has been evolved. If the original information obtained had not been before me I should have had nothing to suggest the course of investigation that followed.

The process of differentiation adopted has been based upon the employment of alcohol, and the determination of the cupric oxide reducing power of the body before and after treatment by boiling with sulphuric acid for conversion into glucose.

By the employment of alcohol, starch and its animal congener, the so-called glycogen, are separable from the dextrins, maltose, and the sugars.

Methylated spirit is what I have used, and it has invariably been submitted to distillation, to secure freedom from chance contamination that might vitiate the result. Actual experience has taught me the necessity of giving attention to this point. The specific gravity of the spirit has stood at about 0·803, which corresponds with the strength of about 97 per cent of alcohol. After separating by alcohol, and collecting the colloidal carbohydrate, its amount has been determined by conversion into glucose, by boiling with sulphuric acid, and estimating the glucose with the ammoniated cupric test. Observation testifies that the process yields extremely delicate and accurate results.

In the case of the dextrins, maltose, and sugars, the differentiation is effected by dividing the product into two equal parts, and taking the cupric oxide reducing power with the ammoniated cupric test of one part in its unaltered state, and of the other part after treatment with sulphuric acid, and to convert into glucose. From the information supplied regarding the condition of the two parts, the nature of the particular carbohydrate present is shown.

When such a plan of procedure is not adopted, and the cupric oxide reducing power is simply taken, no correct information can be obtained as to the nature and quantity of the body present. For instance, the portal blood may contain a low cupric oxide reducing dextrin, and if the cupric oxide reducing power, as it at first exists, were taken as expressive of glucose, which is what in reality has hitherto been done, the amount of carbohydrate actually present would be very much under-stated. At the same time, no information is supplied that the body consists of glucose. It is only by looking at the cupric oxide reducing power before and after treatment with sulphuric acid that a correct knowledge can be acquired, concerning not only the nature but likewise the amount of the principle which is present.

For conversion into glucose, sulphuric acid, to an extent to give a 2 per cent strength in the liquid operated upon, is added. A point to keep in view is to prevent the development of colour, as this interferes with the delicate determination of the result in the subsequent process of titration with the ammoniated cupric test. Hence, as it has been found by experience, it is necessary to use the pure acid.

The condition of the product must be kept in view to secure that the sulphuric acid added is not appropriated by displacing a weaker acid from any saline combination present. The product, if alkaline, must be brought to the neutral state before the sulphuric acid is added, or more sulphuric acid added in order to ensure the 2 per cent strength.

The process of boiling is carried on for different lengths of time according to the nature of the product dealt with. Information about this will be given when the products are being spoken of. When, as with cane sugar, and derivatives of cane sugar, boiling for a few minutes only is required, this can be done in an open flask, but when boiling for a long time, as for one hour or an hour and a quarter is required, it is necessary to use an inverted condenser to prevent loss by evaporation, which entails the risk of the higher degree of acid strength attained occasioning a destruction of carbohydrate. Observation has taught me the necessity of giving attention to this precaution.

What, of course, is wanted is a complete conversion into glucose by the acid treatment. If such is not obtained a vitiated result is given. With some products, as will be seen further on, on account of the resistance offered to conversion, it is advisable to employ a high pressure boiler and raise the temperature to 300° F. (140° C.).

After the conversion has been effected the liquid must be brought to the neutral state before titrating with the ammoniated cupric test. This requires to be done cautiously. A strong solution of potash is used for the purpose, and care must be taken to have the liquid cold before adding the potash, and to see that the temperature does not rise to any material extent during the process, in order to avoid leading to a destruction of glucose. Potash at a high temperature very readily destroys glucose, and by not giving attention to the point referred to error may occur.

With these preliminary remarks I will now proceed to deal with matter in detail.

Grape Sugar.

Grape sugar is characterised by producing the same cupric oxide reducing effect before and after treatment with sulphuric acid.

If by contact with an agent a product is presented which does not possess the same cupric oxide reducing power before and after treatment with sulphuric acid, it must be inferred that the grape sugar has been transformed into another body. Hitherto the carbohydrates have been known to be transformable by increased hydration attended with the acquirement of increased cupric oxide reducing power into grape sugar or glucose, which appears to occupy the position of a final product in the carbohydrate group.

The results to be detailed will show that within the animal system, contrary to existing notions, transformation in the opposite direction occurs, and glucose can be made to move into a product of less cupric oxide reducing power. By boiling with sulphuric acid this product is carried back again into glucose.

A ferment exists in the stomach and intestine of the rabbit which has the property of moving glucose into a body of less cupric oxide reducing power. This statement is substantiated by the following experiments :—

Grape Sugar placed in Contact with Strips of Stomach and Intestine.

Experiment.—The stomach of a recently killed rabbit (at a period of digestion) was removed, emptied of its contents, washed, and divided into two portions along the curvatures. One half was then cut into small strips and placed into a beaker with about 50 cub. centims. of water, and 20 cub. centims. of a solution of grape sugar containing 0·138 grm. of glucose, and exposed for one and a half hours to a temperature of 120° F. (48·8 C.). The contents of the beaker were now boiled with some crystals of sulphate of soda to precipitate the albuminous matters and prepare for testing, filtered (through glass-wool), washed, and the filtrate made up to 100 cub. centims., and divided into two equal parts. One part was titrated at once with ammoniated cupric test, whilst the other was subjected to boiling for one hour and a quarter with 1 cub. centim. o

sulphuric acid (giving a 2 per cent solution) in a flask affixed to a tube connected with an inverted condenser to prevent concentration through loss during boiling. When cold the contents of the flask were neutralised with potash, and brought to a known volume, and this liquid then titrated.

The two titrations showed a cupric oxide reduction reckoned for the whole product equivalent to that producible by the presence of the subjoined amount of glucose:—

Before sulphuric acid .. .. .. 0·080 grm.
After ,, ,, ... 0·134 ,,

Thus 0·138 grm. of glucose were taken, and by contact with the strips of stomach were converted into a body possessing a cupric oxide reducing capacity equivalent only to 0·80 grm. of glucose. By boiling with sulphuric acid this body was carried back into glucose, and it will be observed that the amount of glucose discovered after conversion and re-conversion was 0·134 grm. against 0·138 grm. started with.

The cupric oxide reducing power of the body produced was not far removed from that of maltose, the figures presented 0·080 and 0·134, standing in the relation of 58 to 100 instead of 61 to 100, the figures for maltose.

As a check the other half of the stomach was also cut into strips. These, however, instead of being used at once were first boiled with the 50 cub. centims. of water, and then the 20 cub. centims. of the solution of grape sugar containing 0·138 grm. of glucose were added. The beaker was exposed alongside the other for one and a half hours to 120° F. (48·8° C.). The same subsequent process of precedure as that which has been described was carried out, and the results yielded stood as follows:—

Before sulphuric acid .. .. .. 0·130 grm.
After ,, ,, ... 0·134 ,,

The figures here show that glucose existed. Hence with exposure of the strips to the temperature of boiling water previous to being placed in contact with the glucose no effect was exerted.

The small intestine of the animal was also used in identically the same manner. All the products, indeed, belonging to the experiments were placed side by side and treated alike; as there was enough intestine for the purpose, a duplicate observation was made in that part of the experiment where no preliminary boiling was resorted to. The same solution of grape sugar was used, and the same quantity, viz., 20 cub centims., containing 0·138 grm. glucose. The results of titration yielded the following figures as representing the cupric oxide reducing power of the product before and after subjection to the converting action of sulphuric acid expressed in glucose.

Intestine not subjected to Boiling before Employment.

I. Before sulphuric acid .. .. .. 0·086 grm.
After ,, ,, ... 0·138 ,,
II. Before ,, ,, ... 0·086 ,,
After ,, ,, ... 0·134 ,,

Intestine subjected to Boiling before Employment.

Before sulphuric acid .. .. .. 0·130 grm.
After ,, ,, ... 0·124 ,,

With the intestine, therefore, as with the stomach, no change was induced in the glucose where the strips were previously subjected to the influence of a boiling temperature. On the other hand, where the strips were employed before their activity was destroyed, the glucose was moved so as to make the product possess a reducing power (expressed in percentage relation) of 62 instead of 100 in the one case, and 64 instead of 100 in the other.

Experiment.—A similar experiment was performed with the employment of a larger quantity of glucose, 20 cub. centims. of a sulution of grape sugar, containing 0·400 grm. of glucose, were used, and the time of exposure to 120° (48·8 C.) was two hours.

Duplicate observations were made in the case of the stomach and intestine taken previously to being boiled. The results obtained stood as follows:—

0·400 *grm. of Glucose in Contact with Boiled Strips of Stomach (Rabbit).*

Before sulphuric acid .. .. .. 0·384 grm.
After ,, ,, ... 0·370 ,,

0·400 *grm. of Glucose in Contact with the Fresh Strips of Stomach.*

I. Before sulphuric acid .. .. .. 0·232 grm.
After ,, ,, ... 0·384 ,,
Relation 60 to 100.
II. Before sulphuric acid .. .. .. 0·216 grm.
After ,, ,, ... 0·384 ,,
Relation 56 to 100.

0·400 *grm. of Glucose in Contact with the Boiled Strips of Intestine.*

Before sulphuric acid .. .. .. 0·422 grm.
After ,, ,, ... 0·370 ,,

0·400 *grm. of Glucose in Contact with the Fresh Strips of Intestine.*

I. Before sulphuric acid .. .. .. 0·222 grm.
After ,, ,, ... 0·370 ,,
Relation 60 to 100.
II. Before sulphuric acid .. .. .. 0·200 grm.
After ,, ,, ... 0·384 ,,
Relation 52 to 100.

A marked consistency runs through all these results, except to a certain extent in the figures given by the titration of the product from the boiled strips of the intestine before treatment with sulphuric acid. Here the result comes out rather too high, but absolute accuracy can scarcely be expected to be obtained in every instance. The little loss otherwise noted throughout from the 0·400 grm. of glucose used may not unnaturally be looked for.

No further comment with regard to these experiments is needed. Looked at as a whole they speak in unmistakable terms and furnish a check within themselves.

Grape Sugar inclosed in Stomach and Intestine and exposed to Warmth.

Experiment.—50 cub. centims. of a solution of grape sugar were inclosed in the emptied and cleansed stomach of a freshly killed rabbit. The stomach was laid in a beaker, and exposed for 30 minutes to a temperature of 120° F. (48·8° C.). At the end of this time the contents were collected and submitted to analysis. The cupric oxide reducing power expressed as glucose stood as follows:—

Before sulphuric acid .. .. .. 1·738 grms.
After ,, ,, ... 2·352 ,,

Brought to a percentage relation, the reducing power before and after boiling with sulphuric acid here stands at 73 to 100.

25 cub. centims. of the same solution of grape sugar were also inclosed in a coil of the intestine, and a similar treatment carried out. The results yielded were:—

Before sulphuric acid .. .. .. 0·570 grm.
After ,, ,, ... 1·140 grms.

Here the cupric oxide reducing power of the product before re-conversion into glucose stood in the relation of 50 to 100 after re-conversion.

Experiment.—20 cub. centims. of a solution of grape sugar containing 0·185 grm. of glucose were inclosed in a thoroughly cleansed rabbit's stomach and exposed for two hours to 120° F. (48·8° C.). The analysis then yielded a cupric oxide reducing power expressed as glucose equivalent to:—

Before sulphuric acid .. .. .. 0·102 grm.
After ,, ,, ... 0·184 ,,

These figures stand in the relation of 55 to 100.

The same quantity of the grape sugar solution was introduced into a coil of intestine and similarly dealt with. A duplicate observation was here made. The results yielded were as follows:—

I. Before sulphuric acid .. .. .. 0·108 grm.
After „ „ .. .. .. 0·184 „
Relation 58 to 100.

II. Before sulphuric acid .. .. .. 0·106 grm.
After „ „ .. .. .. 0·180 „
Relation 58 to 100.

Looking at these results we see that the 0·185 grm. of glucose started with was transformed into products possessing a cupric oxide reducing power equivalent to 0·102, 0·108, and 0·106 grm. of glucose, and that after subjection to the re-converting influence of boiling with sulphuric acid, the amount of glucose found very closely corresponded with that actually employed.

Experiment.—20 cub. centims. of a solution of grape sugar containing 0·192 grm. of glucose were inclosed in a cleansed rabbit's stomach and exposed for one hour to a temperature of 120° F. (48·8° C.). An analysis of the contents at the end of this time gave the following results:—

Before sulphuric acid .. .. .. 0·124 grm.
After „ „ .. .. .. 0·184 „
Relation 67 to 100.

The same proceeding was carried out with another stomach, with the difference that the exposure to 120° F. was for two hours instead of one.

Before sulphuric acid .. .. .. 0·112 grm.
After „ „ .. .. .. 0·206 „
Relation 54 to 100.

A similar observation was conducted upon the intestine with the employment of the same quantity of the grape sugar solution; a duplicate was made in the case of the exposure for one hour to the temperature of 120° F.

Subjoined are the results obtained:—

Exposure for one hour to a Temperature of 120° *F.*

I. Before sulphuric acid .. .. .. 0·106 grm.
After „ „ .. .. .. 0·184 „
Relation 57 to 100.

II. Before sulphuric acid .. .. .. 0·108 grm.
After „ „ .. .. .. 0·192 „
Relation 56 to 100.

Exposure for two hours to a Temperature of 120° *F.*

Before sulphuric acid .. .. .. 0·110 grm.
After „ „ .. .. .. 0·184 „
Relation 59 to 100.

(To be continued.)

CANTOR LECTURES OF THE SOCIETY OF ARTS.

The first of a short course of lectures "On the Alloys Used for Coinage" was delivered on Monday evening by Prof. W. Chandler Roberts, F.R.S., of the Royal Mint, the Hon. C. W. Fremantle, C.B., Deputy-Master of the Mint, in the chair.

The Lecturer pointed out that, although the gold coinage of this country is estimated to consist of no less than 700 tons of an alloy of gold and copper, information as to the nature and composition of the alloys used for coinage is far from being widely diffused. The views of many people on this important subject may still be expressed by the words of William Stafford, one of the earliest of English political economists, who, writing in 1581, makes a Knight "confesse that he could not perceave what hinderance it should be to the realme to have this metal more than that for our coyne," provided it "be stricken with the Prince's seale." The operations conducted in a modern Mint are chiefly remarkable for the extreme care and accuracy with which they are conducted. This being the case it was considered advisable to devote the present lecture to tracing the steps by which the machinery and appliances now in use have been arrived at; but it is very difficult to describe the history of the mechanical side of coining chronologically, because progress has been by no means continuous, as certain types of machines have survived persistently in some countries and have been abandoned in others, often to be again introduced with or without modification. Illustrations of this fact were then given. It is safe, however, to conclude that, while in civilised countries, at least since the 13th century, the designs of coins have always fairly represented the artistic culture of the periods at which they were struck, the appliances used in their manufacture have at times been distinctly behind the mechanical science of their days, as indicated in other technical arts. For the last fifty years, until the early part of 1882, the Mint in this country presented a striking example of this fact, as its machinery was admitted to be antiquated, while the general progress of mechanical science during the same period was probably greater than at any other time. It was further pointed out that, viewed from a modern stand-point, there have been periods during which the work of the metallurgist in the purification of the precious metals, and in verifying their standards of fineness, has been greatly in advance of that of the artist who engraved the dies or the mechanician who struck the coins.

The methods adopted by the Greeks in striking coins were indicated, and Prof. Roberts stated that, excepting some uncertainty as to the nature of the metal or alloy used for the manufacture of the Greek dies for coining, we know, thanks to the labours of M. Mongez, nearly as much of the methods adopted as if we had actually seen the ancient coiners at work.

The casting of coins, as conducted in late Roman times, was then described, and, as instances of curious survivals of casting operations, details were given of the production of bars of metal by casting in moulds of wet canvas, as seen by Jars in the Mint at Zellerfeld in the middle of the last century, and of the actual casting of coins of bell-metal in Paris in 1792.

Recent methods of coining were illustrated by cutting discs of metal by means of an appliance formerly used in the Mint in the Tower of London, and by striking them by a press devised in the Paris Mint early in the present century. Prof. Roberts said it had been contended that art had suffered serious loss by the replacement of the old hand-struck money by coins struck by machinery. It was, therefore, not a little remarkable that the artists who were connected with Mints appear to have been the very people to insist on the introduction of mechanical improvements. For instance, to take only the comparatively well-known names from those that were mentioned, Benvenuto Cellini described in 1568 the screw press, which, in a form modified by the genius of Boulton in 1790 so as to enable it to be worked by steam power, has only just been abandoned in the Mint of this country. Leonardo da Vinci, as Dr. Richter has recently shown, devised in 1515, for use in the Roman Mint, a method of "cutting out" discs of metal for conversion into coin, which was a great advance on the crude methods employed in the 16th century. Briot, Engraver-General of the Paris Mint, invented a machine in the reign of King Charles I., which depends upon a principle definitely adopted in the new lever coining-presses of the English Mint; and his pupil Simon, the greatest engraver England has ever had, employed an elaborate mechanical device which enabled him to produce one of the most beautiful coins known. In order to meet the objection that the artistic side of minting was hardly within the province of the chemist, Prof. Roberts quoted Biringuccio, one of the greatest of the early metallurgists, whose advice to a Mint Master, written in 1540, might be briefly stated as follows:—"If the coins are very accurate as regards standards of fineness but small profits can be made, while if too much base metal is introduced the

execrations of the people will follow; but special care should be devoted to the preparation of dies for striking artistic coins, with a view to give the people pleasure in things they are obliged to use."

The next lecture, on Monday the 24th, will be devoted to the consideration of the composition and "standard fineness" of the alloys used in ancient and modern times.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ALUMINUM.

The atomic weight of aluminum has been determined by Berzelius, Mather, Tissier, Dumas, Isnard, Terreil, and Mallet. The early calculations of Davy and of Thomson we may properly disregard.

Berzelius's† determination rests upon a single experiment. He ignited 10 grms. of dry aluminum sulphate, $Al_2(SO_4)_3$, and obtained 2·9934 grms. of Al_2O_3 as residue. Hence, if S = 31·987 and O = 15·9633, Al = 27·243.

In 1835‡ Mather published a single analysis of aluminum chloride, from which he sought to fix the atomic weight of the metal. 0·646 grm. of Al_2Cl_6 gave him 2·056 of AgCl and 0·2975 of Al_2O_3. These figures give worthless values for Al, and are included here only for the sake of completeness. From the ratio between AgCl and Al_2Cl_6, Al = 28·925.

Tissier's‖ determination, also resting on a single experiment, appeared in 1858. Metallic aluminum, containing 0·135 per cent of sodium, was dissolved in hydrochloric acid. The solution was evaporated with nitric acid to expel all chlorine, and the residue was strongly ignited until only alumina remained. 1·935 grm. of Al gave 3·645 grm. of Al_2O_3. If we correct for the trace of sodium in the aluminum, we have Al = 27·073.

Essentially the same method of determination was adopted by Isnard,§ who, although not next in chronological order, may fittingly be mentioned here. He found that 9 grms. of aluminum gave 27 grms. of Al_2O_3. Hence Al = 26·938.

In 1858 Dumas,¶ in connection with his celebrated revision of the atomic weights, made seven experiments with aluminum chloride. The material was prepared in quantity, sublimed over iron filings, and finally re-sublimed from metallic aluminum. Each sample used was collected in a small glass tube, after sublimation from aluminum in a stream of dry hydrogen, and hermetically enclosed. Having been weighed in the tube, it was dissolved in water, and the quantity of silver necessary for precipitating the chlorine was determined. Reducing to a common standard, his weighings give the quantities of Al_2Cl_6 stated in the third column, as proportional to 100 parts of silver:—

1·8786 grms.	Al_2Cl_6 =	4·543 grms.	Ag.	41·352
3·021	,,	7·292	,,	41·459—Bad.
2·399	,,	5·802	,,	41·348
1·922	,,	4·6525	,,	41·311
1·697	,,	4·1015	,,	41·375
4·3165	,,	10·448	,,	41·314
6·728	,,	16·265	,,	41·365

In the second experiment the Al_2Cl_6 contained traces of iron. Rejecting this experiment the remaining six give a mean of 41·344 ± 0·007. Hence Al = 27·441 ± 0·082.

In consequence of these figures of Dumas, the atomic weight of aluminum has generally, of late years, been put at 27·5, and the lower results deduced from the work of other investigators have been disregarded.

In 1879 Terreil* published a new determination of the atomic weight under consideration, based upon a direct comparison of the metal with hydrogen. Metallic aluminum, contained in a tube of hard glass, was heated strongly in a current of dry hydrochloric acid. Hydrogen was set free, and was collected over a strong solution of caustic potash. 0·410 grm. of aluminum thus were found equivalent to 508·2 c.c., or 0·0455 grm. of hydrogen. Hence Al = 27·033.

About a year after Terreil's determination appeared the lower value for aluminum was thoroughly confirmed by J. W. Mallet.† After giving a full resumé of the work done by others, exclusive of Isnard, the author describes his own experiments, which may be summarised as follows:—

Four methods of determination were employed, each one simple and direct, and at the same time independent of the others. First, pure ammonia alum was calcined, and the residue of aluminum oxide was estimated. Second, aluminum bromide was titrated with a standard solution of silver. Third, metallic aluminum was attacked by caustic soda, and the hydrogen evolved was measured. Fourth, hydrogen was set free by aluminum, and weighed as water. Every weight was carefully verified, the verification being based upon the direct comparison, by J. E. Hilgard, of a kilogramme weight with the standard kilogramme at Washington. The specific gravity of each piece was determined, and also of all materials and vessels used in weighings. During each weighing both barometer and thermometer were observed, so that every result represents a real weight *in vacuo*.

The ammonium alum used in the first series of experiments was specially prepared, and was absolutely free from ascertainable impurities. The salt was found, however, to lose traces of water at ordinary temperatures; a circumstance which tended towards a slight elevation of the apparent atomic weight of aluminum, as calculated from the weighings. Two sets of experiments were made with the alum; one upon a sample air-dried for two hours at 21°—25°, the other upon material dried for twenty-four hours at 19°—26°. These sets, marked A and B respectively, differ slightly; B being the less trustworthy of the two, judged from a chemical standpoint. Mathematically it is the better of the two. Calcination was effected with a great variety of precautions, concerning which the original memoir must be consulted. To Mallet's weighings I append the percentages of Al_2O_3 deduced from them:—

Series A.

Grms.		Grms.		
8·2144	of the alum gave	0·9258	Al_2O_3.	11·270 per cent.
14·0378	,,	1·5825	,,	11·273 ,,
5·6201	,,	0·6337	,,	11·275 ,,
11·2227	,,	1·2657	,,	11·278 ,,
10·8435	,,	1·2216	,,	11·266 ,,

Mean 11·2724 ± 0·0014

Series B.

Grms.		Grms.		
12·1023	of the alum gave	1·3660	Al_2O_3.	11·287 per cent.
10·4544	,,	1·1796	,,	11·283 ,,
6·7962	,,	0·7670	,,	11·286 ,,
8·5601	,,	0·9654	,,	11·278 ,,
4·8992	,,	0·5528	,,	11·283 ,,

Mean 11·2834 ± 0·0011

Combined, these series give a general mean of 11·2793 ± 0·0008. Hence Al = 27·075 ± 0·011.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 177.
‡ *Silliman's Amer. Journ.*, 27, 241.
‖ *Compt. Rend.*, 46, 1105.
§ *Ibid.*, 66, 508. 1868.
¶ *Ann. Chim. Phys.*, (3), 55, 151. *Ann. Chem. Pharm.*, 113, 26.

* *Bulletin de la Soc. Chimique*, 31, 153.
† *Phil. Trans.*, 1880, p. 1003.

The aluminum bromide used in the second series of experiments was prepared by the direct action of bromine upon the metal. The product was repeatedly distilled, the earlier portions of each distillate being rejected, until a constant boiling-point of 263·3° at 747 m.m. pressure was noted. The last distillation was effected in an atmosphere of pure nitrogen, in order to avoid the possible formation of oxide or oxy-bromide of aluminum; and the distillate was collected in three portions, which proved to be sensibly identical. The individual samples of bromide were collected in thin glass tubes, which were hermetically sealed after nearly filling. For the titration pure silver was prepared, and after fusion upon charcoal it was heated in a Sprengel vacuum in order to eliminate occluded gases. This silver was dissolved in specially purified nitric acid, the latter but very slightly in excess. The aluminum bromide, weighed in the sealed tube, was dissolved in water, precautions being taken to avoid any loss by splashing or fuming which might result from the violence of the action. To the solution thus obtained the silver solution was added, the silver being something less than a decigramme in deficiency. The remaining amount of silver needed to complete the precipitation of the bromine was added from a burette, in the form of a standard solution containing one milligramme of metal to each cubic centimetre. The final results were as follows, the figures in the third column representing the quantities of bromide proportional to 100 parts of silver. Series A is from the first portion of the last distillate of Al_2Br_6; series B from the second portion, and series C from the third portion:—

Series A.

6·0024 grms.	Al_2Br_6 = 7·2793 grms.	Ag.	82·458
8·6492	,,	10·4897	,,	82·454
3·1808	,,	3·8573	,,	82·462

Series B.

6·9617	,,	8·4429	,,	82·456
11·2041	,,	13·5897	,,	82·445
3·7621	,,	4·5624	,,	82·459
5·2842	,,	6·4085	,,	82·456
9·7338	,,	11·8047	,,	82·457

Series C.

9·3515	,,	11·3424	,,	82·447
4·4426	,,	5·3877	,,	82·458
5·2750	,,	6·3975	,,	82·454

Mean 82·455 ± 0·001

Hence Al = 27·046 ± 0·061.

The high probable error of this result is due to the high probable error of the atomic weight of bromine.

The experiments to determine the amount of hydrogen evolved by the action of caustic soda upon metallic aluminum were conducted with pure metal, specially prepared, and with caustic soda made from sodium. The soda solution was so strong as to scarcely lose a perceptible amount of water by the passage through it of a dry gas at ordinary temperature. As the details of the experiments are somewhat complex, the original memoir must be consulted for them. The following results were obtained, the weight of the hydrogen being calculated from the volume by Regnault's data corrected for the latitude and elevation of the University of Virginia:—

Weight of Al.	Vol. of H.	Wt. of H.	At. Wt.
0·3697 grm.	458·8 c.c.	0·04106 grm.	27·012
0·3769 ,,	467·9 ,,	0·04187 ,,	27·005
0·3620 ,,	449·1 ,,	0·04019 ,,	27·002
0·7579 ,,	941·5 ,,	0·08425 ,,	26·998
0·7314 ,,	907·9 ,,	0·08125 ,,	27·006
0·7541 ,,	936·4 ,,	0·08380 ,,	26·996

Mean 27·005 ± 0·0032

The closing series of experiments was made with larger quantities of aluminum than were used in the foregoing set. The hydrogen, evolved by the action of the caustic alkali, was dried by passing it through two drying tubes containing pumice stone and sulphuric acid, and two others containing asbestos and phosphorus pentoxide. Thence it passed through a combustion-tube containing copper oxide heated to redness. A stream of dry nitrogen was employed to sweep the last traces of hydrogen into the combustion-tube, and dry air was afterwards passed through the entire apparatus to reoxidise the surface of reduced copper, and to prevent the retention of occluded hydrogen. The water formed by the oxidation of the hydrogen was collected in three drying tubes. The results obtained were as follows. The third column gives the amount of water formed from 10 grms. of aluminium:—

2·1704 grms.	Al gave	2·1661 grms.	H_2O.	9·9802
2·2355	,,	2·9292	,,	9·9785
5·2632	,,	5·2562	,,	9·9867

Mean 9·9818 ± 0·0017

Hence Al = 26·998 ± 0·007.

In combining the various determinations of the atomic weight of aluminum into one general mean, we must arbitrarily assign weight to the single experiments of Berzelius, Isnard, Tissier, and Terreil. This may fairly be done by giving to each the probable error, and therefore the weight, of a single observation in Dumas's series. Mather's work may be ignored altogether:—

From Berzelius	Al = 27·243	±	0·201
,, Tissier	,, 27·096		0·201
,, Isnard	,, 26·938		0·201
,, Dumas	,, 27·441		0·082
,, Terreil	,, 27·033		0·201
,, Mallet's alum experiments	,, 27·075		0·011
,, ,, Al_2Br_6	,, 27·046		0·061
,, ,, H	,, 27·005		0·003
,, ,, H_2O	,, 26·998		0·007
General mean	,, 27·0092		0·0028

If O = 16, Al = 27·075. Taking Mallet's work alone, Al = 27·0089 ± 0·0028.

Evidently all the data except Mallet's might be rejected without affecting sensibly the final result. Dumas's work is clearly vitiated by constant errors, but the determinations by Isnard, Tissier, and Terreil may be regarded as having some confirmative value.

The following additional note has been communicated by the author:—

Since the chapter on aluminum was written, a new determination has been made by Baubigny.* Two calcinations of $Al_2(SO_4)_3$, left a mean percentage of Al_2O_3 of 29·832. Hence Al = 26·983; or, if SO_3 = 80, Al = 27·018.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 22nd, 1884.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"*On a New Variety of Halloysite from Maidenpek, Servia*," by H. E. ROSCOE, LL.D., F.R.S, President

This mineral, one of the few peculiar to Servia, was given to me by Mr. James Taylor, lately a resident at Maidenpek. It is a very soft (h. = 2·5), whitish green, non-crystalline mineral, having a conchoidal waxy fracture. It is translucent in thin films, but opaque in mass,

* *Comptes Rendus*, 97, 1369.

and adherent to the tongue. Its specific gravity is 2·07. On exposure to air it loses a portion of its combined water, and becomes of a dead-white colour and more opaque. The greenish tint is due to the presence of small quantities of copper oxide (1·11 per cent). The following analyses show that this is a more highly hydrated variety than most of the specimens of Halloysite hitherto examined, and that it corresponds to the formula $Al_2O_32SiO_2+5H_2O$.

Analysis of Halloysite from Maidenpek.

	I.	II.	Mean.
Al_2O_3	32·81	32·58	32·69
SiO_2	37·59	37·70	37·64
H_2O	28·59	28·27	28·43
CuO	1·11	—	1·11
	100·10	—	99·87

The calculated composition for the above formula is—

Al_2O_3	32·86
SiO_2	38·37
H_2O	28·77
	100·00

A specimen of a similar mineral from the same locality was found by Tietze to contain :—

$Al_2O_3(Fe_2O_3)$	25·20
SiO_2	44·96
H_2O	29·50
	99·66

Corresponding nearly with the formula $Al_2O_33SiO_2+6H_2O$, showing a distinct difference in the relation of alumina to silica from that existing in the specimen in question.

"*On a Method of Mounting Electrical Resistances*," by Arthur W. Waters, F.G.S., &c.

NOTICES OF BOOKS.

Annual Report of the Director of the Mint to the Secretary of the Treasury, for the Fiscal Year ending June 30th, 1883. Washington : Government Printing Office, 1883.

The interest that is attached to this report, chiefly statistical, is of a two-fold character, and such as will render its study by those who are at all interested in the highly complex question regarding the monetary state of the world one of considerable value. The first part of the report relates to the operations of the Mints and Assay Offices in the United States during the fiscal year ending June 30th, 1883, and the present state of the coinage and metallic circulation. In the second part are printed the reports received from foreign Mints regarding their monetary statistics in reply to the enquiries addressed to the different Governments by the United States Secretary of State in reference to the condition of their gold and silver coinage and currency. By the aid of the information that has been thus furnished a fair estimate is obtained of the world's coinage, the paper and specie circulation of the principal countries of the world and the production of gold and silver in the world. Besides the customary statistics relating to the coinage operations at the different Mints in the United States, tables are given showing the production of gold and silver and the consumption of these metals in the arts and manufactures and the total United States circulation and its disposition. A few legislative measures are recommended with a view to the discontinuance of the coinage of certain pieces which are considered unsuitable as media of exchange and also the repeal of the act authorising the coinage of the trade dollar.

A Digest of Patent Law and Cases, incorporating the Provisions of the Patents Act, 1883. By H. A. A. Gridley, M.A., Barrister-at-law. London : Marcus Ward and Co.

In the preface to this useful volume the compiler states that the object of the work is "to present as concisely as possible the Law of Patents, altered as it is by the Patents for Inventions Act, 1883." Considerable pains have evidently been taken in carrying out this object, and so rendering the book one that will be of service both to the numerous class of inventors who require to have some knowledge of the law relating to patents and to the legal profession. The full and clear manner in which the legal technicalities of each clause are expounded, and the large number of cases quoted bearing on the different points, and the decisions that have been arrived at, will render this treatise a useful one for reference.

In the introductory chapter a short historical sketch is given of the origin of monopolies in this country, followed by a *précis* of the procedure now necessary for obtaining a patent compared with the procedure that formerly existed under the repealed Patents Acts, showing in a concise manner the alterations that have been effected by the new Act. The first two chapters, in which are discussed "the true and first Inventor" and the Invention, will afford much information regarding these two knotty questions to those intending to seek legal protection for their inventions by showing how far the manner of a new manufacture or its novelty may legally claim to have a patent granted. These matters form a useful introductory to the main part of the volume, on the proceedings under the new Patents Act, which is divided into chapters in which the various sections of the Act are analysed and much matter illustrative of the legal points introduced, cases cited, decisions quoted, &c. In an appendix are given the rules made by the Board of Trade relating to applications for patents for inventions, registration of patents, list of fees, and rules for appeals to the law officers.

The British Journal Photographic Almanac and Photographer's Daily Companion for 1884. Edited by W. B. Bolton. London : Henry Greenwood.

Even if the usual item of Almanacs, eclipses of the sun, had been omitted, which phenomena, fortunately for photographers, are by the nature of things of very unfrequent occurrence and of short duration, this volume would still possess much matter useful for all classes of photographers and sufficient in variety and extent to fill up advantageously leisure moments for no inconsiderable time. In addition to a mass of contributions, "literary and scientific," many of them from the pens of men well known in photographic spheres, we have much information of a more solid character in the way of receipts for developers and such like which may perhaps be found more or less valuable by the photographer who has time or inclination for experimental work. The progress that has been made during the past year by the enthusiastic workers in this nineteenth century art, and the extent and rapidity with which this instructive form of amusement is spreading, as is shown by the number of new photographic societies that have sprung up, are duly recorded by the editor in his summarised notes. The most noteworthy achievements of photography for science during the period are undoubtedly Mr. Common's picture of the nebula in Orion, and the photographic work connected with the eclipse of last May.

Among many other notes that the amateur or professional photographer may find to be of considerable use to him, especially if his knowledge of chemistry is limited, that on atomic and equivalent weights will be of material assistance in working out the calculations connected with double decomposition. Here, in addition to the atomic weights of many compounds used by the photographer, which by the way ought rather to have been termed molecular weights, the "equivalent" weights are given referred

to one uniform scale, the salts of monad elements. This method of tabulating these numbers, although in certain cases advantageous, is open to some objections, liable to mislead those whose notions of chemical decompositions are at all hazy. For instance, in the case of crystallised salts, if weighed in such a form, their water of crystallisation, if they possess any, would require to be taken into account; but such weights could not certainly be called "equivalent" in the true chemical sense, and why should these molecules of water be considered as forming part of the "equivalent" weight in such a compound as citric acid and ignored in baric chloride or sodic carbonate?

Report of the Commissioner of the Imperial Mint for the year ending the 30th of the 6th month of the 16th year of Meiji (*30th June*, 1883). Hiogo: 1883.

This the 13th Report of the Imperial Mint of Japan for the financial year ending the 30th of June, 1883, gives the usual statistics respecting the imports of gold and silver bullion into the Mint, and the amounts of these metals that have passed through the coinage department during the last year. The total value of the coins, gold, silver, and copper, that have been struck at the Mint since its commencement has reached the sum of 108,966,830·75 yen.

Some new regulations have been introduced with regard to the acceptance of bullion for coinage purposes, and for refining. Formerly the smallest quantities of bullion received for coinage were 50 ozs. of gold and 500 ozs. of silver; these amounts have now been reduced to 30 ozs. and 300 ozs. respectively. The charges made for coining or refining these metals have likewise been changed.

The part of this report which most interests us is that relating to the chemical department of the Mint, which is under the supervision of Mr. W. Gowland, F.C.S. The Japanese, we notice, carry on their bullion refining as well as the manufacture of sulphuric acid, soda, and some other chemicals in conjunction with their coining processes. In refining their bullion the ordinary sulphuric acid method is employed; the mother-liquors from which the cupric sulphate has been separated by crystallisation are concentrated by evaporation, and the recovered acid again used in the process. The amounts of the pure metals obtained from the refinery for the past year were about 64,000 ozs. of gold and 806,000 ozs. of silver. The decrease that has taken place in the demand for cupric sulphate has caused the introduction of Gutzzkow's process—precipitation of the silver by ferrous sulphate—as mentioned in the last report; data, however, are not given to show how far this method, exceedingly good on a small scale, can be carried on economically when dealing with large quantities of the metals. Besides the manufacture of nitric, hydrochloric, and sulphuric acids, as well as of soda, a building has been erected for the making of bleaching-powder. The trials that have been made, however, of this last addition to the establishment have not been quite satisfactory, owing to the defective character of the chlorine generator and the heat of the weather.

An interesting analysis is given of an ingot of silver which was of such brittleness that on attempting to cut out an assay piece from it it broke into halves. The analysis showed no zinc, arsenic, or antimony, but 0·756 per cent of bismuth and 0·857 per cent of lead, with traces of gold, copper, and iron. When purifying such silver by cupellation it is found that the lead appears to be more easily oxidised than the bismuth, the latter metal being obstinately retained by the silver. The preliminary results obtained from an investigation of silver bismuth alloys demonstrate that (1) brittleness of silver is frequently due to the presence of bismuth; (2) if bismuth is present in certain proportions in an ingot of silver, the ingot will not be uniform in composition; (3) when bismuth and lead have to be removed from silver by oxidation the former metal is only removed after most of the latter has been oxidised.

An unusually large quantity of gold has been found in the crude copper from certain of the Government mines; in one case as much as 26 ozs. of the precious metal have been found per ton of the copper.

The Mechanical Department of the Japanese Mint, under the able superintendence of Mr. MacLagan, has now taken the form of a complete engineering works capable of constructing all the necessary machines as well as effecting repairs, thus rendering the establishment greatly independent of external aid.

CORRESPONDENCE.

WARNING.

To the Editor of the Chemical News.

Sir,—I wish to call the attention of Managers of Chemical Works and Analytical Chemists to the following letter which appeared in the *Western Morning News* of March 17:—

"Sir,—The public are warned against a young German-Swiss, who is going about the South of England pretending to seek employment, and stating falsely that he was assistant to Stevenson Macadam, professor of chemistry, of Edinburgh. He was at Falmouth on the 11th inst., and gave the name of Weiss, saying that he was from Zurich. The police doubtless will be glad to hear of his whereabouts.—Yours truly, A. Lloyd Fox, Penmere, Falmouth, March 15th, 1884."

I have no doubt this is the same person who favoured most of the Chemical Works in this neighbourhood with a visit about a month since, and succeeded in several instances in obtaining pecuniary assistance.

Introducing himself as Dr. Weisse, he represented himself to be an Analytical Chemist, Ph.D. (Heidelberg), and F.C.S., stating that he had been employed at the St. Rollox Works, and giving Professor Ramsay, of Bristol, as a reference, &c.

Prof. Ramsay said that he does not know such a person, neither can I find that name in the list of Fellows of the Chemical Society for 1883.—I am, &c.,

Henry S. Billing.

The Plymouth Chemical Works, Plymouth.
March 18th, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 3, January 21, 1884.

Dust accompanying Snow.—M. Nordenskiöld.—Snow which fell near Stockholm about the end of December was contaminated with small quantities of a black dust. A little of this matter which had been collected was found to contain much carbonaceous matter. On ignition it left a red residue of ferric oxide, silica, phosphorus, cobalt, and nickel, the two latter in relatively large proportions.

Conductivity of very Dilute Saline Solutions.—E. Bouty.—The author has experimented upon solutions so dilute that their density and viscosity differed little from those of pure water. Their electric conductivity was still enormous in comparison with that of pure water, and was closely connected with their chemical composition. Let

p be the weight of salt contained in the unit of weight of the solution, e its chemical equivalent, c the conductity of a liquid cylinder of a length and section taken as unity. There is for each salt a value p, below which the conductivity varies proportionally to the weight of the dissolved salt: if we compare the conductivities of the various salts we find that they are inversely as the equivalents, and we may write $c=k\frac{p}{e}$. The coefficient k is the same for all the neutral salts which the author has studied. If we put $p=e$, *i.e.*, if we consider solutions which contain in like volume the same number of mols. of the different salts, the conductivity c is the same for all. The molecular conductivity of all neutral salts is the same.

Repulsion of Two Consecutive Portions of the same Current.—M. Izarn. The author remarks that in Ampère's experiment for demonstrating this repulsion no one has yet noticed that if we turn the apparatus so that the current traversing the mercury is obliged to return in order to pass through its horizontal portions, these latter must be attracted, whilst the effects upon the other portions remain as in the first case.

Formation of Nacreous Crystals of Sulphur.—D. Gernez.—If we take a U-tube, the diameter of which does not exceed 0·002 metre, introduce sulphur into it, and heat to 160°, and then plunge it into boiling water, the liquid produces the desired variety of crystalline sulphur.

Determination of the Equivalent of Chromium by means of its Sesqui-sulphate.—H. Baubigny.—The author's mean result is Cr=26·016 if S=16, or Cr=26·050 if S=16·037. In a later experiment he finds Cr=26·081 or 26·116, according as S=16, or =16·037. The determinations of Kessler gave Cr=26·15, and those of Siewert Cr=26·047.

The Liquefaction of Hydrogen.—M. Wroblewski.—Condensed hydrogen refrigerated by means of boiling oxygen becomes liquefied when released from pressure.

Products of the Reduction of Erythrite by Formic Acid.—A. Henninger.—Formic acid causes the polyvalent alcohols to descend successively in their valence. If erythrite is boiled with 2½ parts of formic acid for six hours, and the excess of acid is subsequently distilled off, raising the temperature at the end towards 190° to 200°, the residue congeals into a radiating mass containing tetraformine, and yielding on destructive distillation crotonylene-glycol, crotonic-aldehyd, dihydro-furfurane, and erythrane.

An Aromatic Diacetone.—C. Louise.—The author has obtained dibenzoyl-mesitylene by causing benzoyl-chloride to react upon benzoyl-mesitylene.

Determination of Moisture in Amylaceous Matters.—L. Bondonneau.—Moist starch, if suddenly heated to temperatures above 60°, produces a paste which forms an impenetrable stratum in which the moisture of the interior is imprisoned. The author proposes the following process:—If the sample is free from acidity, 5 to 10 grms. are weighed out, and spread in a thin stratum in a rectangular capsule of glass, porcelain, or platinum, which is then introduced into a cold Courlier stove. The temperature is then raised slowly and gradually (in about three hours) to 60°; then it is raised to 100° in one hour, and this heat is maintained until the weight is constant. If the sample is acid it must be cautiously neutralised with ammonia, and is then kept until nearly dry at a heat not above 40°, when it is raised to 100° as before.

Moniteur Scientifique, Quesneville.
February, 1884.

Preparation of the Pentathionates and on Pentathionic Acid.—S. Shaw and Watson Smith.—From the *Journal of the Chemical Society*.

Magnesium Bromide and Iodide.—Otto Lerch.

Oxides of Manganese.—O. T. Christenson.—These two papers are from the *Journal fur Praktische Chemie*, and have been noticed under that head.

Certain Bromo-derivatives obtained in the Manufacture of Bromine.—S. Dyson.—From the *Journal of the Chemical Society*.

Oxidation of the Sulphur Compounds in Caustic Soda-lye.—Dr. G. Lunge.—In presence of an excess of soda, sodium sulphite is transformed during concentration into hyposulphite, by the action of the atmospheric oxygen alone. If the lye at the moment of caustification is agitated by means of a current of air, the sulphide disappears entirely. But, subsequently, when the concentration has raised the boiling-point to about 140°, the hyposulphite splits up into sodium sulphide and sulphite. The former may be again oxidised by the same process, and the cycle of reactions being repeated all the sulphide may be converted into sulphite; but this change, at temperatures below 360°, requires a very long time. Sodium sulphite is oxidised by the air to sulphate, the more rapidly the higher the temperature; at a red heat the introduction of a current of air converts all the sulphide into sulphate. Sodium sulphide may also be oxidised by means of nitre. The reaction begins below 140°, and if the oxidising agent is not in excess, which is always the case in practice, it is entirely changed into nitrite. This body subsequently reacts upon the sulphide, not yet attacked, and converts it into sulphite. There the reciprocal action ends, the sulphite and nitrite remaining in presence of each other up to nearly 360°. At this temperature sulphate is formed with liberation of nitrogen. The action of nitrate never produces hyposulphite. That which is formed in the crude caustic lyes is produced at the expense of atmospheric oxygen. The hyposulphite is relatively very stable. The nitre passes at first into the state of nitrate, which, in presence of oxidisable sulphur, is totally reduced with liberation of ammonia. This reaction begins at about 140° in iron vessels. Along with the production of ammonia, which reaches its maximum at 180°, and still continues above 300°, the formation of free nitrogen is observed. The maximum useful effect with nitre is obtained by causing it to react at a low temperature. We are thus led to the following rational procedure:—The sulphide is first oxidised to hyposulphite by means of atmospheric oxygen. As the hyposulphite is only oxidised slowly by the air when the temperature has reached 140° there is no splitting up into sulphide and sulphite. It is well not to add the nitre until the temperature has risen to the decomposition point into sulphide and sulphite, and to introduce it then by small quantities. In practice the first dose of nitre is added as soon as the presence of sodium sulphite is detected in the liquid, and the last portions about 300° to 360°.

Solid and Liquid Illuminating Agents.—L. Field.—Lectures delivered before the Society of Arts.

Antiseptics and Bacteria.—P. Miquel.—The author has drawn up a table of the minimal proportions capable of preventing the putrefaction of 1 litre of beef broth neutralised. The most powerful agent is mercury biniodide, which is ten times as active as chlorine. Salicylic and benzoic acids, phenol and arsenious acid, occupy relatively very low ranks. The smallest quantities required are mercury biniodide, 0·025 grm.; chlorine, 0·25; salicylic acid, 1·00; phenol, 3·00; arsenious acid, 6·00; naphthaline has no antiseptic action.

German Patents for Improvements in Colouring Matters.—A list of abridgments of specifications.

Determination of Free Fatty Acids in Oils.—Ch. E. Schmitt.

Adulterations of Industrial Chemical Products carried on abroad.—A further reference to the tartar-emetic question.[6]

Journal de Pharmacie et de Chemie.
Tome ix., February, 1884.

Emetics of Mucic and Saccharic Acids.—D. Klein.—From the *Comptes Rendus.*

Naphthol.—An account of the medicinal uses of this compound, which appears to be not unattended with danger.

Citric and Tartaric Acids.—B. J. Grosjean.—From the CHEMICAL NEWS.

The Absorption-spectrum of Blood in the Violet and Ultra-violet Region.—J. L. Soret.—From the *Comptes Rendus.*

The Existence and Distribution of Eleidine in the Bucco-œsophagian Mucous Membrane of Mammals.—L. Ranvier.—From the *Comptes Rendus.*

Cosmos les Mondes,
No. 2, January 12, 1884.

Siliceous Bronze.—H. Vivarez proposes a siliceous bronze as the best material for telegraph and telephone wires. Its conductive power is comparable to that of copper, and its mechanical resistance is superior to that of iron. For wires of galvanised iron weighing 155 kilos. per kilometre may be substituted wires of this bronze weighing only 28 kilos. Siliceous bronze does not rust like iron, but becomes covered with a film of oxide, which is a good insulator.

No. 3, January 19, 1884.

Utilisation of Woollen and Cotton Rags.—M. Heddebault has invented a method for extracting wool in the state of a solution from tissues in which cotton and wool are mixed. On submitting the rags to a current of superheated steam at the pressure of 5 atmospheres, the wool melts, and falls to the bottom of the vessel, while the cotton or other vegetable matter remains in a state fit for use in paper-making. The dissolved wool may be evaporated to dryness, but remains soluble in water, and is used by manure-makers as a source of nitrogen under the name of azotine. [This process was in use at Wakefield more than a quarter of a century ago!—*Ed.* C.N.]

No. 4, January 26, 1884.

This issue does not contain any chemical papers.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., November, 1883.

Action of Light upon Colours.—M. Decaux.—Already noticed.

Revue Universelle des Mines, de la Metallurgie, &c., Nos. 2 (Sept. and Oct.) and 3 (Nov. and Dec.), 1883.

These numbers contain no chemical matter.

MISCELLANEOUS.

The Parkes Museum.—Sir Joseph Lister, Bart, will take the Chair at the Parkes Museum on Thursday, March 27, at 8 p. m., when Mr. Watson Cheyne will give a demonstration of all the principal types of Micro-organisms. Tickets for admission can be obtained through Members of the Museum.

Skrivanow Battery.—D. Monnier.—The element is formed of a sheet of zinc and of silver chloride wrapped in parchment paper, immersed in an alkaline liquid of 75 parts of potassa in 100 of water. The case is a small trough of gutta-percha, capable of being hermetically closed. The conductors and outer contacts are of silver. The entire element weighs 100 grms. The electromotive force of this element is 1·45 to 1·50 volts, and it can give a current of 1 ampère for about an hour.—*Comptes Rendus.*

MEETINGS FOR THE WEEK

MONDAY, Mar. 24th.—Medical, 8.30.
—— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
TUESDAY, 25th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
WEDNESDAY, 26th.—Society of Arts, 8. "Vital Steps in Sanitary Progress," by B. W. Richardson, M.D.
THURSDAY, 27th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
FRIDAY, 28th.—Royal Institution, 8. "The Two Manners of Motion of Water," by Prof. Osborne Reynolds, at 9.
—— Society of Arts, 8. "Trade Routes in Afghanistan," by Griffin W. Vyse.
—— Quekett Microscopical Club, 8.
SATURDAY, 29th.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

Wanted, Situation as Assistant Manager or Chemist in Chemical Works. Thorough practical and theoretical knowledge of paraffin oil industry, sulphate of ammonia, and coal-tar products. Highest references.—Address, Z.Y.Z., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, Situation as Chemist or Manager in Alkali or Manure Works. Over eleven years' experience. Thorough practical knowledge of vitriol, salt-cake, soda-ash, crystals and bleaching-powder (Weldon). First class testimonials.—Address, H. E. T., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

MANAGER OF A TAR WORKS.

Wanted, a competent, practical Chemist to take charge of a Tar Works, distilling from 4000 to 6000 tons of tar per annum, and to be responsible for commercial success of same. Must be well up in the rectification of benzol and the manufacture of anthracene, and must also have some knowledge of the manufacture of sulphate of ammonia.—Apply, stating full particulars as to experience, giving references, and stating salary required, to R. Dempster, senr., Gas and Chemical Engineer, Elland, Yorkshire.

PHOSPHO-GUANO COMPANY, LIMITED, SEACOMBE.

Wanted, a General Manager for this Company. For one possessing a good technical knowledge, superior commercial ability, and great experience, a very liberal remuneration will be given. All communications will be treated as strictly confidential.—Apply by letter, addressed Chairman, Phospho-Guano Company, Limited, Seacombe, Cheshire.

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All the furnaces and boilers are connected by underground flues with one large circular stack, 150 ft. high and 10 ft. internal diameter.

For particulars apply to Complex Ore Co., Lim., Swansea, or to Mr. H. Dever, 4, Lothbury, London.

FOR SALE.—New Chemical Works, with Vacant Land attached, bounded by canal with wharfage and highway: three miles from Manchester Exchange. Plant and machinery nearly all new, and on the best principle for the making of Aniline, Nitro, Binitro-benzole, and other coal-tar products; Stills for rectifying Benzole, &c. Also Plant partly erected for carbonising coal.—Address, S. Charlton, Ellesmere Park, Eccles, near Manchester.

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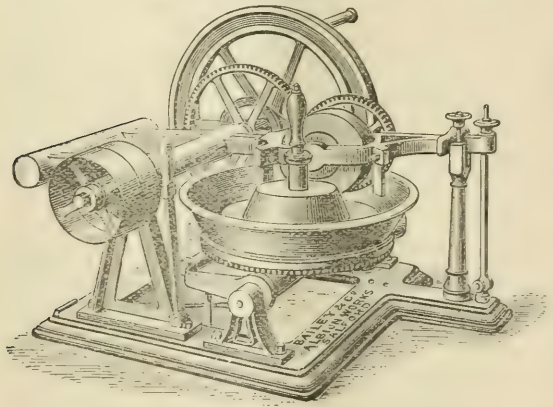

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1270.

ON A METHOD OF MOUNTING ELECTRICAL RESISTANCES.*

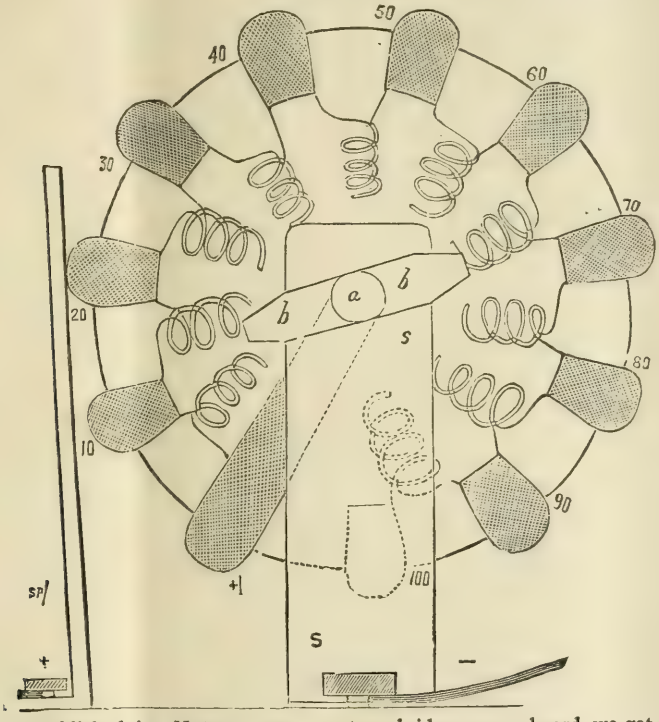
By ARTHUR W. WATERS, F.G.S., &c.

A SHORT time ago I came to the conclusion that there was a strong probability of the variations in the electrical resistances of the human body giving some indication as to how various climatic changes affected different constitutions. This idea forced itself on me in consequence of an investigation concerning the changes of the body temperature, as affected by meteorological conditions, having brought out the interesting fact, that the average changes in the 5 to 6 p.m. clinical temperature of a sufficient number of invalids† follows the curve of the absolute moisture or of the temperature, both of which are very similar

Dr. Stone's results, as published in *Nature*, gave a definite direction to the idea, and then, when considering how I could carry out what I proposed, I saw that I must first have an instrument by which measurements could be rapidly made and changes easily followed, and if possible, the current should not be broken by altering the measure.

The ordinary resistance box with plugs cannot be used sufficiently rapidly and is unsuitable. I therefore adopted the plan of mounting the resistance reels on an ebonite disk, with a metal axis (*a*) running at each end in brass supports, s. This support has a binding screw at the base and the current is thus led away from the axis. Round the border of this disk German silver flanges* or bosses are attached, and one of these (*x*) is connected by a stout strip of copper to the axle. Between this and the next boss a resistance coil of fine German silver wire wound double on a small reel is attached, and between each of the other bosses a similar coil is placed and the two ends severally soldered to the adjoining German silver projection. The disk is revolved by means of a bone or ebonite handle, *b*, and these bosses are thus brought against a strong spring (*sp*), up which the current is led. If the flange connected with the axle is brought against this spring, then there is practically no resistance ; but if any other flange is against the spring, then the current must pass through one or more reels of resistance. As figured it would go through two reels of 10 ohms each, and if it went through all the reels we get a total of 100 ohms. As arranged, one boss does not leave the spring until the next is in contact.

The complete instrument consists of four such disks similarly mounted and put into connexion, and on the first disk the reels are 1 ohm, on the second 10, and on the other two 100 and 1000 respectively, so that they are read off like a gas meter, and thus a resistance from 1 ohm to 11,110 ohms can be read directly, and by mounting the commutator and the permanent arms of the Wheat-



stone bridge on one board, we get a very compact instrument, and have all the handles within easy reach for rapid change. About 7 centimetres will be found ample for the diameter of the disk, and the whole apparatus may be mounted on a board about 45 centims. long and 10 centims. wide.

The arrangement of resistances is much the same as in slide resistances, and the plan of arranging these in a circle has been used for medical purposes, but I am not aware of the resistances themselves being made to revolve, though I have not had any opportunity of investigating all the plans previously adopted. It seems to me, however,

* A Paper read before the Manchester Literary and Philosophical Society, January 22, 1884.

† The measurements were made for the purpose by consumptive people in Davos.

* These flanges overlap on each side and therefore present to the spring a continuous surface the width of the disk.

that in cases where only amateur or imperfect workmanship is available, that this will be found the simplest plan, and also, I think that when compactness and rapidity of action are important this form may often be found useful, and, therefore, describe it although there is no new principle involved.

One such disk may also be used when a galvanic current is being applied for medical purposes, in which case the current is made to first pass through a high resistance of several reels, and then without contact being broken the resistance is brought down to null. In such cases it may be found advisable to make the first resistance much lower than the last.

CHLORINATION OF PYROGALLOL: TRI-CHLORO-PYROGALLOL.

By C. S. S. WEBSTER, F.C.S.

THIS subject has been studied by Stenhouse and Groves, and the results of their investigations were published some years since (*Chem. Soc. Journ.*, 1875, 704). Recently working on this subject, in conjunction with Messrs. Cross and Bevan, and in connection with their researches upon the formation of phenol derivatives in plants, I made a closer examination of the first stage of the chlorination of pyrogallol (in solution in glacial acetic acid) noticed by the above-named chemists. I have satisfactory proof that it consists in the production of a tri-chloro derivative $C_6Cl_3(OH)_3$, which is obtained crystallising in the form of needles, with $3H_2O$.

As far as I have been able to ascertain no derivatives of this formula have hitherto been obtained.

I hope to lay a full account of my investigation before the Chemical Society, and therefore content myself at present with this bare record of its chief result.

ON THE PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 131.)

Grape Sugar inclosed in Stomach and Intestine, and these immersed in Water for Diffusion to occur.

Experiment.—A solution of grape sugar was inclosed in the stomach of a freshly-killed rabbit which had been emptied of its contents, and thoroughly rinsed through with water. The stomach was then immersed in about 100 c.c. of water contained in a beaker, and the beaker exposed for thirty minutes to 120° F. (48·8° C.). At the end of this time a portion of the water was taken from the beaker for analysis, and the beaker and its contents were afterwards placed on one side and exposed to the ordinary temperature for twenty-four hours. The water in the beaker and the contents of the stomach were now respectively subjected to analysis. The two portions of water removed from the beaker only required to be measured, divided into two equal parts, and titrated before and after boiling with sulphuric acid, used as is always the case in the proportion to give a 2 per cent solution. The contents of the stomach were treated with crystals of sulphate of soda, boiled, filtered, and washed, and the filtrate brought to a known bulk and divided into two equal parts.

One part was titrated at once, and the other, after the process of boiling with sulphuric acid, conducted in the usual manner. Subjoined are the results yielded:—

Water from Beaker at the end of thirty minutes.

Before sulphuric acid	0·012 grm.
After ,, ,, ...	0·012 ,,

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·086 grms.
After ,, ,, ...	0·160 ,,

Contents of Stomach at the end of twenty-four hours.

Before sulphuric acid	0·526 grm.
After ,, ,, ...	0·768 ,,

These results show that at the end of half-an-hour only a very small portion of the contents of the stomach had reached the surrounding water, and that this first diffusate consisted of unchanged glucose at the end of 24 hours, the water contained a product with cupric oxide reducing power of 53 as compared with 100 for glucose, and the contents of the stomach 67 against 100.

The intestine was used in a similar manner. Here a duplicate observation was made, and in each case a length of intestine of about 20 inches was employed. The results yielded were as follows:—

I. *Water from Beaker at the end of thirty minutes.*

Before sulphuric acid	0·016 grm.
After ,, ,, ...	0·016 grm.

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·208 grm.
After ,, ,, ...	0·384 ,,

Contents of Intestine at end of twenty-four hours.

Before sulphuric acid	0·415 grm.
After ,, ,, ...	0·768 ,,

II. *Water from Beaker at the end of thirty minutes.*

Before sulphuric acid	0·020 grm.
After ,, ,, ...	0·020 ,,

Water from Beaker at the end of twenty-four hours.

Before sulphuric acid	0·250 grm.
After ,, ,, ...	0·588 ,,

Contents of Intestine at the end of twenty-four hours.

Before sulphuric acid	0·454 grm.
After ,, ,, ...	0·768 ,,

In both these observations, as in the case of the stomach, the water at the end of half-an-hour contained unchanged glucose in small amount. The water at the end of twenty-four hours contained a product with the reducing power, in the one case of 54 and in the other 42 to 100 for glucose; with the contents of the intestine the glucose had been transformed so as to give a cupric oxide reducing power of 54 and 59 instead of 100.

Experiment.—20 c.c. of a solution of grape sugar were enclosed in a rabbit's stomach as in the previous experiment, and the stomach placed in a beaker containing 100 c.c. of water, and exposed to a temperature of 120° F. (48·8° C.). Water was removed from beaker at end of one hour for examination, and the beaker and the contents afterwards allowed to remain two hours longer at a temperature of 120° F. (48·8° C.), when the water and contents of stomach were taken for analysis.

The following were the results yielded:—

Water from Beaker at the end of one hour.

Before sulphuric acid	0·008 grm.
After ,, ,, ...	0·008 ,,

Water from Beaker at the end of three hours.

Before sulphuric acid	0·010 grm.
After ,, ,, ...	0·018 ,,

Contents of the Stomach at the end of three hours.

Before sulphuric acid	0·624 grm.
After ,, ,, ...	1·052 ,,

* A Paper read before the Royal Society, Dec. 20th, 1883.

The figures show glucose in small amount in the water contained in the beaker at the end of one hour, and a product with the reducing power of 55 to 100 for glucose in the water at the end of three hours, and 59 to 100 in the contents of the stomach.

The intestine was employed in a similar way, and the results obtained stood as follows:—

Water from Beaker at the end of one hour.

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·022 ,,

Water from Beaker at the end of three hours.

Before ,, ,, ... 0·060 ,,
After ,, ,, ... 0·060 ,,

Contents of the Coil of the Intestine at the end of three hours.

Before sulphuric acid .. .. .. 0·554 grm.
After ,, ,, ... 1·052 ,,

It is noticeable that the water in the beaker at the end of three hours contained glucose. I hardly know how this disparity is to be explained, and must simply give the figures just as they were yielded. The product in the intestine at the end of three hours possessed a reducing power of 52 to 100 for glucose.

Experiment.—20 c.c. of a solution of grape sugar were enclosed in the cleansed stomach of a freshly-killed rabbit, and the stomach placed in a beaker containing about 100 c.c. of water, and exposed for two hours to a temperature of 120° F. (48·8° C.). On submitting the water in the beaker and the contents of the stomach to analysis at the end of this time, the following results were obtained:—

Water from the Beaker at the end of two hours.

Before sulphuric acid .. .. .. 0·044 grm.
After ,, ,, ... 0·078 ,,
Relation before and after sulphuric acid, 56 to 100.

Contents of the Stomach at the end of two hours.

Before sulphuric acid .. .. .. 0·104 grm.
After ,, ,, ... 0·204 ,,
Relation 50 to 100.

The intestine similarly treated gave the following results:—

Water from Beaker at the end of two hours.

Before sulphuric acid .. .. .. 0·040 grm.
After ,, ,, ... 0·052 ,,

Contents of the Intestine at the end of two hours.

Before sulphuric acid .. .. .. 0·104 grm.
After ,, ,, ... 0·216 ,,

Here the water in the beaker contained a product with a reducing power of 76 in relation to 100 as the reducing power of glucose, whilst the intestine contained a body with a reducing power of only 48 to 100.

Experiment.—In a like experiment to the last, with the exception that the exposure to 120° F. (48·8° C.) was one hour and a-half instead of two hours, the subjoined results were obtained:—

Water from Beaker at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·006 grm.
After ,, ,, ... 0·006 ,,

Contents of Stomach at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·142 grm.
After ,, ,, ... 0·256 ,,
Relation 55 to 100.

Duplicate observations were made with the intestine.

I. *Water from Beaker at the end of one and a-half hours.*

Before sulphuric acid .. .. .. 0·054 grm.
After ,, ,, ... 0·082 ,,
Relation 65 to 100.

Contents of Intestine at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·140 grm.
After ,, ,, ... 0·270 ,,
Relation 51 to 100.

II. *Water from Beaker at the end of one and a-half hours.*

Before sulphuric acid .. .. .. 0·062 grm.
After ,, ,, ... 0·084 ,,
Relation 73 to 100.

Contents of Intestine at the end of one and a-half hours.

Before sulphuric acid .. .. .. 0·146 grm.
After ,, ,, ... 0·270 ,,
Relation 54 to 100.

Experiment.—Two lengths, each of about 20 inches, of thoroughly cleansed rabbit's intestine were charged with 20 cub. centims. of a solution of grape sugar, placed in beakers containing 100 cub. centims. of water, and exposed for one hour to a temperature of 120° F. At the end of this time the usual analysis was performed.

I. *Water from the Beaker at the end of one hour.*

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·034 ,,

Contents of Intestine at the end of one hour.

Before sulphuric acid .. .. .. 0·118 grm.
After ,, ,, ... 0·172 ,,

II. *Water from Beaker at the end of one hour.*

Before sulphuric acid .. .. .. 0·020 grm.
After ,, ,, ... 0·035 ,,

Contents of Intestine at the end of one hour.

Before sulphuric acid .. .. .. 0·120 grm.
After ,, ,, ... 0·178 ,,

In these duplicate observations the results show that the water from the beaker contained a body with a reducing power in the one case of 58, and in the other of 57, as compared with glucose at 100. The contents of the intestine in each case possessed a reducing power of 68 to 100.

Situation of Converting Principle.

I at first took it for granted that the probable seat of the active principle which which had effected the transformation of glucose into a product of lower cupric oxide reducing power was in the superficial surface of the mucous layer. Uuder this impression I operated with the scrapings from the surface of the mucous membrane. The idea has proved to be erroneous, but it occasioned me for some time a considerable amount of embarrassment through the want of constancy and positiveness in my results. I generally, but not invariably, obtained a sufficiently marked effect, especially when a large quantity was used with the scrapings from stomach and intestine of the rabbit, but in the case of the other animals that I tried—pig, sheep, horse, cat, and dog—my results were such as to lead me to consider that no action which could be regarded as of physiological significance was exerted. Such a conclusion, however, was difficult to accept, for I had ascertained in some of the animals mentioned, as I shall subsequently bring forward experiments to show, that when grape sugar was introduced into the stomach it reached the portal vein not as glucose but as a body of about the cupric oxide reducing power of maltose. I have since dealt with the entire coats of the stomach and intestine of the pig, cat, and dog, used after being finely cut up with scissors, and have found marked transformative action exerted. I have not made any precise comparative observations, but from what I have seen I am under the impression that the stomach and the intestine of the rabbit act more enegetically than the stomach and intestine of the other animals I have tried. It also appears to me that the stomach acts more energetically than the intestine, and in some instances I have noticed that the effect pro-

duced has stood in relation to the amount of ferment material used.

A review of my experiments led me to take the entire walls instead of the scrapings from the inner surface, and I then obtained the results which have been already described. I have, however, tested the question experimentally by operating with the scrapings and the deeper part separately, and the results show in a decided manner where the active principle is situated. Perhaps the reason of my formerly getting positive results to the extent I did with scrapings from the stomach and intestine of the rabbit was on account of the delicacy of the structures in this animal leading to more or less of the deeper part being removed with the superficial.

Experiment.—The cleansed stomach of a recently-killed rabbit was divided into two longitudinal halves along the curvatures. One-half was used entire and after being minutely divided was placed in a beaker with about 50 cub. centims. of water. The other half was lightly scraped upon the surface, and the scrapings also placed in a beaker with a similar quantity of water. The remaining deeper portion was finely divided, and then disposed of in a like manner. Into each beaker 10 cub. centims. of a solution of grape sugar containing 0·142 grm. of glucose were placed, and the products were then exposed side by side for two hours to a temperature of 120° F. (48·8° C.).

The intestine was also at the same time dealt with in a similar way, and the subjoined figures show the results that were obtained:—

Entire Walls of the Stomach.

Before sulphuric acid	.. .. ..	0·102 grm.
After „ „	.. .. ..	0·134 „

Scrapings of Inner Surface.

Before sulphuric acid	.. .. ..	0·134 grm.
After „ „	.. .. ..	0·134 „

Part left after Removal of Inner Surface.

Before sulphuric acid	.. .. ..	0·100 grm.
After „ „	.. .. ..	0·134 „

Entire Walls of the Intestine.

Before sulphuric acid	.. .. ..	0·118 grm.
After „ „	.. .. ..	0·138 „

Scrapings of Inner Surface.

Before sulphuric acid	.. .. ..	0·142 grm.
After „ „	.. .. ..	0·138 „

Part left after Removal of Inner Surfac

Before sulphuric acid	.. .. ..	0·118 grm.
After „ „	.. .. ..	0·138 „

(To be continued.)

ON THE CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.*

By IRA REMSEN and E. H. KEISER.

In a paper recently published† we described some experiments which led us to the conclusion that when a mixture of carbon monoxide and air is brought in contact with moist phosphorus there is no oxidation of the monoxide. This conclusion is directly opposed to that reached by Leeds‡ and by Baumann,‖ according to whom the oxidation is easily effected. If these chemists are right, it follows that when moist phosphorus acts upon oxygen, something is formed which is distinct from free oxygen and from ozone. To this the name active oxygen has been given. Since our paper appeared, both Leeds§ and Baumann* have published the results of new experiments, and, as we suggested that their error might be due to the action of ozone on organic substances present, such as cotton-wool, rubber, corks, &c., they have carefully avoided such contact. Leeds finds no occasion to modify in the slightest degree his first statement on the subject. Baumann, however, who has taken great care in the construction of his apparatus, and whose paper gives clear indications of accurate work, obtains results which differ in some respects from those described by him in his first paper.† In the latter, in speaking of the passage of the mixture of air and carbon monoxide over the phosphorus, he says "das vorgelegte Barytwasser wird schon nach kurzer Zeit trübe und im Laufe einer Stunde bildet sich ein reichlicher Niederschlag von kohlensaurem Baryt." In this experiment the gases were used in the proportion three volumes of oxygen to one of the monoxide. The whole description is such as to leave upon the mind of the reader the impression that the oxidation is very easily effected. In his last paper Baumann is much more cautious, and, though he still insists that the carbon monoxide is oxidised, the extent of the oxidation appears to have been much less than in the first experiments. Instead of getting an abundant precipitate (reichlicher Niederschlag), only a small one was obtained, and the formation of this required a much longer time, as appears from the following passage:—"Nach den ersten zwei Stunden zeigte sich schon eine deutliche Trübung. . . . die von da ab stetig zunahm: da der Niederschlag hauptsächlich im Innern der Zuleitungsröhre . . . abgeschieden wurde, wurde letztere nach weiteren 10 Stunden verstopft."

Another point which arrests attention when the paper is read critically is this, that in order to get evidence of oxidation, very large volumes of air mixed with a little monoxide are passed over the phosphorus. In one case 200 c.c. of the monoxide are admitted every two hours In another the author speaks of using 700 c.c. of the monoxide "in starker Verdünnung mit Luft," the passage requiring 15 hours. The amount of carbon dioxide obtained was 0·0366 grm. or 2·6 per cent of the monoxide was oxidised. In still another experiment, a mixture consisting of 30 litres of air and 2·45 litres of the monoxide occupied 12 hours in passing the phosphorus, the amount of carbon dioxide obtained being 0·0646 grm., representing the oxidation of 1·3 per cent of the monoxide.

Of course there can be no objection to using large volumes of air, provided it can be shown by blank experiments that no error is introduced in consequence, and this Baumann appears to have done. Speaking of passing air alone through the apparatus he says:—"Hält man den Luftstrom so, dass . . . in der Secunde nicht mehr als zwei bis drei Blasen hindruchtreten, so entsteht . . . auch nach mehreren Tagen nicht mehr als eine ganz leichte Trübung von phosphorsaurem resp. phosphorigsaurem Baryt."

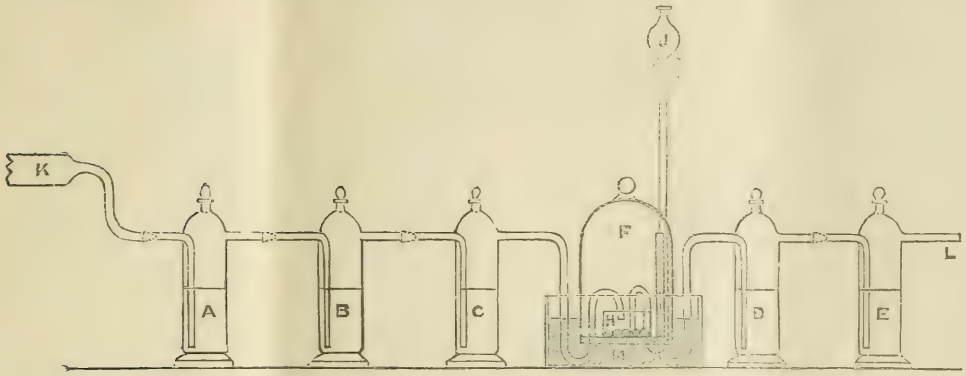
Passing now to Leeds's new experiment, but a few words will be necessary. This writer filled a glass-stoppered 10-litre flask with a mixture of equal parts of carbon monoxide and air, and allowed the mixture to stand in contact with moist phosphorus for six days. Then the glass stopper was removed, replaced by a cork, and, the mouth of the vessel being placed under mercury, the gaces were displaced and passed through baryta water. A precipitate representing 0·0155 grm. of carbon dioxide was obtained. There is one source of error in this experiment which should be noted at once. It is clear that by standing for six days in the tightly closed vessel, the oxygen of the air must have been completely used up, so that the gases were necessarily under diminished pressure. Apparently, in taking out the glass stopper for the purpose of introducing the cork, no precautions were taken to prevent access of ordinary air, and a considerable volume of ordinary air must have entered; not enough certainly to give the quantity of carbon dioxide obtained, but enough to cause

* *Amer. Chem. Journ.*, vol. v., No. 6.
† *Ibid.*, iv., 454.
‡ *Journ. Amer. Chem. Soc.*, i., 322.
‖ *Zeitschrift für Physiologische Chemie*, v., 250.
§ Chemical News, xlviii., 25

* *Berichte der Deutschen Chemischen Gesellschaft*, xvi., 2146.
† *Loc. cit.*

a perceptible precipitate in the baryta water. Another source of error, however, much more serious than this, and quite sufficient to account for the result, has since been discovered by us.

Although we felt convinced of the accuracy of our first work and the correctness of the result, we have nevertheless subjected the work to a careful revision. Working with the precautions previously used, we have obtained exactly the same results as at first. On studying Baumann's paper, however, it seemed to us possible that there might be a slight oxidation, so slight as to escape notice when comparatively small volumes of the gases are used. Now, in most of our first experiments small volumes were used, and we therefore felt it incumbent upon us to go over the work, using larger volumes. We first passed thoroughly purified air through an apparatus which was so arranged as to prevent all contact of ozone with organic substances. The current was fully as slow as that in Baumann's experiments, and the gases, after passing out of the ozonising vessel, were washed with a rather larger quantity of water than was used by Baumann. A cloudiness began to appear in the baryta water after six or eight litres of air had passed through, and this increased constantly, until when 25 to 30 litres had passed in 12 to 15 hours a distinct precipitate, not a mere turbidity, was in the vessel containing the baryta water. The precipitate was carefully



examined with reference to the presence of phosphorus compounds, but not a trace could be detected. The experiment was repeated with the same result. It is clear, therefore, that in spite of Baumann's explicit statement, there is some source of carbon dioxide independent of carbon monoxide, and before accurate experiments can be made this source must be discovered and if possible avoided.

Karsten* has shown that when air alone comes in contact with the organic matter of corks and connectors, carbon dioxide is formed, and that if a large volume of air is first freed from carbon dioxide and then passed through lime water, a precipitate is formed, unless all contact with organic matter is prevented. Storer† has recently confirmed this observation. It hence seemed possible that the carbon dioxide obtained from the air in our experiment might be formed either from the organic matter in the air or by the action of the air on the rubber connectors and corks of the wash bottles used in purifying it, and our next step was to so arrange our apparatus as to absolutely exclude all organic matter. This was effected by means of an apparatus illustrated in outline in the figure. The wash-bottles A, B, C, D, E, were made for us by a skilful glassblower. They are fitted with glass stoppers, and the escape tube of each fits air-tight into the entering tube of the next one by means of a ground glass joint. The tube, K, only partly represented in the figure, is about 14 inches long and of hard glass. The vessel, F, is an ordinary bell-jar, holding about one and a quarter litres. This is held in position on mercury contained in a crystallising dish. Upon the mercury floats a smaller vessel, in which the phosphorus is placed. The tube from the last wash bottle through which the air is passed before it comes in contact with the phosphorus is bent so as to pass beneath the edge of the bell-jar, then up into the closed space above the mercury, and then down towards the phosphorus. The tube through which the carbon monoxide is passed into the vessel is arranged in the same way. A long funnel tube, J, is bent in a similar way, but reaches down to the bottom of the dish containing the phosphorus. By means of it the phosphorus can be covered with water or uncovered, as may be desired, without disarranging the apparatus. The tube through which the gases pass out of the bell-jar is bent like the two already referred to, with the exception that it is not directed downward after entering the vessel, but is allowed to project nearly to the top of the space. All joints which are not of ground glass are carefully fitted by means of gypsum.

This is the apparatus exactly as it was used in a number of experiments with air alone. The method of experimenting was as follows:—The air was contained in a gasometer holding 30 litres. From this it was passed slowly, at the rate of about two or three bubbles per second, into the hard glass tube, K, containing copper oxide heated to dull redness; then through the three wash-bottles, the first two containing caustic soda and the last one baryta water. It was then passed into the bell-jar containing the phosphorus. Care was taken to keep the air in this vessel as near 24° as possible, and the white fumes indicating the action of the phosphorus were always abundant during the course of an experiment. The amount of phosphorus exposed, that is, not covered by water, varied from 20 to perhaps 70 or 80 grms., the usual amount being between 20 and 30 grms. From the bell-jar the ozonised air with whatever it contained passed through the wash-bottle, D, containing from 30 to 40 c.c. of pure distilled water, and then into the concentrated baryta water. The last bottle, E, containing the baryta water, was connected with a tube containing caustic potash to protect it from the ordinary air.

We cannot see how any exception can be taken to the apparatus used by us, or to the method of conducting the experiments. Nevertheless, working under what appear to us to be perfect conditions, we obtained exactly the same result as we had obtained in the first experiments with air, viz., the air alone when passed for a sufficient length of time gave a precipitate in the last bottle. Ten litres of air always cause a distinct turbidity, and twenty to thirty give a precipitate. As there was no possible source of error, it follows that the carbon dioxide obtained must have come from carbon contained in the phosphorus. There is no escape from this conclusion. That there should be carbon in phosphorus is not surprising when we consider the method of manufacture, and the fact that

* *Poggendorff's Annalen*, cxv., 348.
† *Amer. Chem. Journ.*, v., 69.

boron, silicon, iron, &c., which are made by similar methods, all contain small quantities of this element. Indeed the presence of carbon in the phosphorus as it is at first obtained is well known, and, in the purification process adopted, chromic acid is used for the purpose of removing it. *A priori* we would hardly expect the process of purification to be complete, and our experiments furnish the proof that it is not.

Whether the carbon is present in the phosphorus in chemical combination or not is a question difficult to answer. We can only say that the phosphorus used by us appeared to be perfectly homogeneous. There was no evidence of the presence of particles in it. Its solution in carbon bisulphide was clear, and on standing nothing whatever was deposited. Some of the phosphorus which we used had been carefully re-distilled by us. This made no difference in the result. These facts lead us to believe that the carbon is in chemical combination with the phosphorus.

We have made some attempts to estimate the quantity of carbon present, but have not been successful. A simple way to show its presence is to burn a piece of phosphorus in a small porcelain dish floating on water under a bell-jar fitted with a glass stopcock. After the combustion is over, the vessel is allowed to stand for some time until the white fumes have entirely disappeared. The gas is then passed through water, and finally into baryta water, where a not insignificant precipitate is invariably formed. The air in the bell-jar must, of course, be purified. As the vessel is lifted only far enough to permit the introduction of the dish with the phosphorus, and this operation is performed instantaneously, the amount of carbon dioxide introduced with the air can be only infinitesimal.

The complete oxidation by means of chromic acid of a weighed quantity of phosphorus, and estimation of the carbon dioxide formed, gave unsatisfactory results, for the reason that it was impossible to regulate the action and at the same time secure complete oxidation of the phosphorus. With concentrated solutions the action is liable to become very violent unless the temperature is kept low. By means of the experiments with chromic acid we were able to demonstrate the presence of the carbon by the formation of a precipitate of barium carbonate; but though the precipitate was weighed in a few cases, the results are of little value, as the action was evidently incomplete.

Similar experiments with nitric acid were equally unsuccessful as quantitative analyses, though they also clearly showed the presence of carbon.

Finally an apparatus was arranged similar to that used for making phosphorus pentoxide on the small scale. The combustion was effected in pure air, and after being thoroughly washed the gases were passed through baryta water. Again a precipitate was formed, but the operation was far from perfect, owing to the formation of a considerable quantity of red phosphorus, and to imperfect oxidation.

For the present we have given up the attempt to estimate the quantity of carbon in phosphorus, and content ourselves with having proved beyond question that it is present in sufficient quantity to interfere with such delicate experiments as those upon the oxidation of carbon monoxide.

We now made some experiments with the object of determining how far changes in the amount of phosphorus exposed in the ozoniser perceptibly changed the amount of barium carbonate formed. We found that the amount of the precipitate is plainly influenced by the rate of passage of the gases, the temperature, and the amount of phosphorus exposed, but that, if the temperature is between 20° and 25°, the rate of passage of the air about two or three bubbles per second, and the amount of phosphorus exposed from 20 to 30 grammes, a slight precipitate is always formed by 10 litres of air, and that 25 to 30 litres give a very decided precipitate.

It does not of course follow, from the facts above described, that carbon monoxide is not oxidised by air in the presence of moist phosphorus, but it is clear that in experiments undertaken for the purpose of deciding the question allowance must be made for the presence of carbon in the phosphorus. The amount of allowance to be made cannot be determined with accuracy, for the amount of phosphorus exposed cannot be perfectly controlled in the apparatus used. The best way to reach a positive conclusion is to perform parallel experiments under as nearly the same conditions as possible, one with air alone, the other with air and carbon monoxide. If the vessels in which the precipitates are formed are of the same shape and size, and each contains the same amount of baryta water, we can judge with a fair degree of accuracy whether a larger precipitate is formed in one case than the other.

In making these comparisons about 25 litres af air were first passed through the apparatus, the conditions being carefully noted. The bottle containing the precipitate formed was removed at the end of the operation, instantly stoppered and placed aside for comparison. The water was then removed from the wash-bottle and replaced by fresh distilled water, a new bottle attached in the place of E, and, after passing about a litre of pure air through the apparatus, the necessary quantity of baryta water filtered rapidly through a plaited filter into the wash-bottle. Now the experiment was repeated with the difference that during the passage of the 25 litres of air, a very slow current of carefully purified carbon monoxide (made from pure sulphuric and formic acids) was passed through three wash-bottles like those used for the air and containing the same substances, and then, through the tube described above, brought into the presence of the phosphorus and air. The rate of the current was so regulated that, during the time of the experiment, which varied in different cases from three to eight hours, 3 litres of the monoxide were used. The same slow formation of a precipitate was noticed when the carbon monoxide was used as in the case of air alone. At the end of the operation we were unable to distinguish any difference between the amounts of the small precipitates formed. In neither case did this amount appear to be as great as that found by Baumann. The precipitates were too small to permit of accurate filtering and weighing, if we consider the nature of the liquid in which they were present. Comparing their size with that of certain larger precipitates which we did weigh, we estimated that they could not possibly weigh more than 1 to 2 m.grms. If there was any difference between them it could not have amounted to more than a small percentage of the total weight, and, as already said, no difference was apparent. The only conclusion which we can draw is, as we claimed in our first publication on this subject, that carbon monoxide is not oxidised by air in the presence of moist phosphorus.

The precipitate obtained by Leeds, which he ascribed to oxidation of the carbon monoxide, must have been due mainly to the oxidation of the carbon in the phosphorus. We have shown that the amount of carbon dioxide formed by burning phosphorus in a few litres of pure air is considerable; quite enough, we should judge, to give a precipitate as large as that obtained by Leeds.

The fact that Baumann obtained precipitates when working with large volumes of air is easily understood; but that they should have been as large as they were is not easily explained. That only a slight turbidity should have been obtained after several days, on passing air alone through the apparatus, is beyond our comprehension.

That in our first experiment we should have obtained no evidence of the presence of carbon is due to the fact that we worked with small volumes of the gases. In those cases in which relatively large volumes were used the slight cloudiness produced was disregarded, as the same result was obtained with air alone. We are further inclined to think that the moist asbestos through which the gases were passed may have retained a small quantity of the carbon dioxide. We have found that this method of

filtering is quite superfluous, and that the water in the small wash-bottle is sufficient to retain all traces of phosphorus compounds. Phosphorus could never be detected in the precipitate of barium carbonate, and indeed, when the current was as slow as usual, phosphorus compounds were not found in the first wash-bottle.

Although our experiments have cost us a great deal of time and labour, the apparatus finally used is simple and the experiments may be repeated with comparatively little trouble. We therefore hope that others who may be interested in the subject may find the time to repeat them. It is however, absolutely necessary that all the precautions mentioned by us be taken.

It certainly appears remarkable that carbon monoxide is not oxidised by air in the presence of moist phosphorus where the formation of ozone is constantly taking place. If our ordinary conceptions in regard to this process are correct, the phosphorus splits up the molecules of oxygen and unites with some of the atoms thus set free, while other oxygen atoms rearrange themselves in the form of ozone molecules. There should, according to this conception, be free atoms of oxygen in the immediate vicinity of the phosphorus, and the first thought would naturally be that an unsaturated compound like carbon monoxide must be oxidised. That it is not is, however, quite in accordance with its conduct towards ozone during the transformation of the latter into ordinary oxygen. One of us (R.) has shown* that, if carbon monoxide be mixed with ozone, and the mixture passed through a tube heated to about 300°, a temperature sufficiently high to transform all the ozone into oxygen, no oxidation of the monoxide takes place. In this experiment we have conditions exactly the opposite of those involved in the phosphorus experiment. In both cases, however, according to the prevailing notions, free atoms of oxygen ought to be formed and to exist in the interval, however brief it may be, between the breaking up of the ozone and the formation of oxygen or the splitting up of the molecules of oxygen and the formation of ozone.

Why carbon monoxide is not oxidised by ozone itself under ordinary circumstances is a question which it is impossible to answer in the present state of our knowledge; still less can we imagine a reason for the fact that it is not oxidised by the gases formed when ozone is broken up by heat, nor by those formed during the production of ozone by the action of phosphorus on moist air.

There is at present then only one experiment on record which seems to show that by starting with ordinary oxygen this can be so changed as to acquire the power to oxidise carbon monoxide at lower temperatures. This is the experiment of Baumann† with palladium hydrogen. In view of the fact that Traube has shown that palladium‡ and hydrogen dioxide together can readily oxidise the monoxide, an observation which we have confirmed,‖ and that hydrogen dioxide is formed, though apparently in small quanity, by the action of palladium hydrogen on air and water, the question as to the cause of the oxidising action of palladium hydrogen may fairly be regarded as an open one.

The observation of Leeds that when a mixture of carbon monoxide and air is submitted to the silent electrical discharge carbon dioxide is formed, furnishes no evidence of the formation of active oxygen, as Andrews and Tait§ have called attention to the fact that when the silent discharge acts upon carbon monoxide alone some dioxide is formed.

A Gas Burner giving a White Light by the Incandescence of Magnesia.—Ch. Clamond.—The author's arrangement with a consumption of 180 litres of gas per hour give a light equal to 4 carcels.—*Comptes Rendus.*

* *Amer. Chem. Journ*, iv., 50.
† *Zeitschrift fur Physiologische Chemie*, v., 250.
‡ *Berichte der Deutschen Chemischen Gesellschaft*, xv., 2854.
‖ *Amer. Chem. Journ.*, iv., 454.
§ *Philosophical Transactions*, 1860, p. 126.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

GOLD.

The only determinations of the atomic weight of gold which are worthy of consideration are those of Berzelius and of Levol.

The earliest method adopted by Berzelius† was that of precipitating a solution of gold chloride by means of a weighed quantity of metallic mercury. The weight of gold thus thrown down gave the ratio between the atomic weights of the two metals. In the single experiment which Berzelius publishes, 142·9 parts of Hg precipitated 93·55 of Au. Hence, using the value for mercury given in a preceding chapter, 199·712, Au = 196·113.

In a later investigation‡ Berzelius resorted to the analysis of potassio-auric chloride, $2KCl.AuCl_3$. Weighed quantities of this salt were ignited in hydrogen; the resulting gold and potassium chloride were separated by means of water, and both were collected and estimated. The loss of weight upon ignition was, of course, chlorine. As the salt could not be perfectly dried without loss of chlorine, the atomic weight under investigation must be determined by the ratio between the KCl and the Au. If we reduce to a common standard, and compare with 100 parts of KCl, the equivalent amounts of gold will be those which I give in the last of the subjoined columns:—

Grms. K_2AuCl_6.		Grm. KCl.		Grms. Au.	
4·1445	gave	0·8185	and	2·159	263·775
2·2495	,,	0·44425	,,	1·172	263·815
5·1300	,,	1·01375	,,	2·67225	263·600
3·4130	,,	0·674	,,	1·77725	263·687
4·19975	,,	0·8295	,,	2·188	263·773

Mean 263·730 ± 0·026

Hence Au = 196·186 ± 0·101.

Still a third series of experiments by Berzelius‖ may be included here. In order to establish the atomic weight of phosphorus he employed that substance to precipitate gold from a solution of gold chloride in excess. Between the weight of phosphorus taken and the weight of gold obtained, it was easy to fix a ratio. Since the atomic weight of phosphorus has been better established by other methods, we may properly reverse this ratio and apply it to our discussion of gold. 100 parts of P precipitate the quantities of Au given in the third column:—

0·829 grm. P	precipitated	8·714	Au.	1051·15
0·754	,,	7·930	,,	1051·73

Mean 1051·44 ± 0·196

Hence Au = 195·303 ± 0·589.

Levol's§ estimation of the atomic weight under consideration can hardly have much value. A weighed quantity of gold was converted in a flask into $AuCl_3$. This was reduced by a stream of sulphur dioxide, and the resulting sulphuric acid was determined as $BaSO_4$. 1 grm. of gold gave 1·782 grms. $BaSO_4$. Hence Au = 195·794.

If we give this single experiment and Berzelius's single result with mercury each equal weight with one analysis in the potassio-auric chloride series, and include respectively the probable errors appertaining to Hg and to $BaSO_4$, we may combine all the data as follows:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 177.
‡ *Lehrbuch*, 5 Aufl., 3, 1212.
‖ *Ibid.*, 5th Aufl., 3, 1188.
§ *Ann. d. Chim. et d. Phys.*, (3), 30, 355. 1850.

From KCl : Au ratio	Au = 196·186	±	0·101
„ Hg : Au ratio	„ 196·113		0·335
„ P : Au ratio..	„ 195·303		0·589
„ $BaSO_4$: Au ratio.. ..	„ 195·794		1·234
General mean..	„ 196·155		0·095

Or, if O = 16, Au = 196·606.

As gold is a metal which can be readily applied to the determination of the atomic weights of other elements, an experimental revision of its atomic weight is very desirable.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 20, 1884.

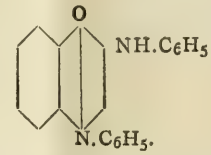
Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—W. D. Borland, A. F. Dimmock, J. Gaskell, W. H. Perkin (jun.), A. G. Perkin, J. W. Pratt.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Drs. P. Frankland and Morley, duly elected Fellows:—F. W. Brown, H. Cave, F. W. Fleming, E. E. Graves, A. E. Lewis, J. E. London, G. A. Parkinson, S. Smith, G. Tunbridge, T. U. Walton.

Mr. TRIBE then read a "*Note on the Preparation of Marsh-Gas*," by J. H. GLADSTONE and A. TRIBE. In 1873 (*Chem. Soc. Journ.*, xi., 682) the authors described two reactions in which marsh-gas was produced free from other hydrocarbons by the action of the copper-zinc couple on methyl-iodide in the presence of water or alcohol. The loss of methyl-iodide was, however, considerable, varying from 23 to over 50 per cent. In the present note the authors describe a slight modification of the apparatus, by means of which this loss can be prevented. About 600 grms. of thinly granulated zinc are immersed in a 2 per cent solution of copper sulphate until the latter is decolourised. The copper-zinc couple is washed with water, and finally with alcohol. It is introduced into a flask, the mouth of which is closed by a doubly-perforated cork. Through the cork pass the end of a stoppered funnel containing the methyl-iodide, and the end of an upright wide glass tube 12 ins. long and 1 in. in internal diameter, filled with copper-zinc couple. The upper end of this tube is also closed by a doubly-perforated cork, into which fit a delivery-tube and the end of a stoppered funnel containing alcohol. This upright tube serves the double purpose of a copper-zinc scrubber and an inverted condenser. A mixture of 20 c.c. of alcohol and 20 c.c. of methyl-iodide being allowed to run into the flask, a steady evolution of marsh-gas proceeds. The first litre was evolved in eight minutes. 7053 c.c. were obtained, the theoretical yield being 7100 c.c. The reaction can be much expedited by gently heating the flask.

The SECRETARY then read a paper "*On the Action of Dibrom-a-Naphthol upon Amines*," by R. MELDOLA. In a preliminary note (CHEMICAL NEWS, vol. xlvii., p. 27) the author called attention to the remarkable facility with which dibrom-*a*-naphthol entered into reaction with certain amines, forming, in the case of aniline, para-toluidin and β-naphthylamin, well characterised crystalline bases. The action of this dibrom-naphthol upon diamines has been made the subject of a patent by L. Casella and Co. (German Patent No. 20850), and the reaction has been investigated by R. Möhlau (*Berichte*, 1883, 2853). The author therefore confines himself to a description of some results of the action of dibrom-*a*-naphthol upon monamines. On mixing dibrom-*a*-naphthol with about three times its weight of aniline, a white crystalline mass of aniline-dibrom-naphtholate is formed. On heating to nearly the boiling-point of aniline the contents of the flask acquire a deep reddish-brown colour: the reaction is complete in about ten minutes; when cool the mass forms a solid cake of crystals. The substance was purified by washing and re-crystallisation from boiling alcohol, and formed orange-red needles melting at 179°. It possessed basic properties, and agreed with the diphenyl-di-imido-naphthol of Goes and Zincke. The zinc and platinum salts were prepared and analysed, and the identity of the substance with β-naphtho-quinon-dianilide conclusively established. With ortho-toluidin a similar reaction took place, but nothing separated out on diluting the contents of the flask with alcohol. With para-toluidin similar results were obtained, and the product crystallised out in silky orange needles, melting at about 175°. A crystalline body was also formed when naphthylamine was used. The action of dibrom-*a*-naphthol upon amines therefore furnishes a most simple method of obtaining these quinone-imide derivatives in large quantities. The author then discusses the significance of this production, as affording an insight into their constitution, and considers that the constitution of β-naphtho-quinone-dianilide must be—



The SECRETARY then read "*A Note on the Existence of Salicylic Acid in the Cultivated Varieties of Pansy and in the Violaceæ generally*," by A. B. GRIFFITHS and E. C. CONRAD. The authors have extracted colourless acicular crystals from pansy leaves, &c., soluble in ether, alcohol, and boiling water, which gave with ferric chloride a violet colour. A combustion gave numbers agreeing with the formula of salicylic acid. The leaves yielded 0·13 per cent, the stems 0·08 per cent, the roots 0·05 per cent, whilst the flowers contained only a trace. The authors cut sections of the leaves, &c., but failed to discover any crystals of salicylic acid in the cells.

The Society then adjourned to April 3. The Anniversary Meeting will be held March 31.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, March 22, 1884.

Prof. F. GUTHRIE, President, in the Chair.

THE PRESIDENT announced that a meeting of the Society would be held on May 10, at Birmingham, by invitation. The next meeting will be on April 26.

Professor S. P. THOMPSON then read a paper by himself and Mr. C. STARLING, "*On Hall's Phenomenon*." The authors had not agreed with Hall's explanation of his observed effect, and last year undertook experiments to investigate its nature. They employed a strip of tin-foil gummed on a mahogany board with vaseline, which being soft and a non-conductor answered well for this purpose. A top-shaped electro-magnet with a pointed pole was used on one side of the strip to try the effect of a pointed pole. The current was obtained from accumulators. They found that the equipotential lines in the strip, which before magnetisation ran straight across the strip, were slightly curved on either side of the pointed pole after magnetisation. This curving was interpreted as a reduction of resistance in the strip at the pole, and subsequent tests of the resistance of the strips in a magnetic field confirmed this view. Iron strips, however, showed a slight *increase* of resistance. It was also found that an effect similar to Hall's was got by placing the pointed pole so that this change of resistance was not symmetrical with respect to the points in the strip to which the galvanometer was con-

nected. But inasmuch as this effect was not reversible by reversing the magnetism, it was not Hall's effect which they failed to obtain with the narrow pointed pole. In their experiments thermo-electric results were eliminated, and their results, though different, do not clash with those of Mr. Bidwell.

A Paper by Mr. Herbert Tomlinson on the same subject was read by Professor Reinold. The author drew attention to a similarity between Hall's table of results and one of his on the effects of mechanical stress on electrical resistance.

Mr. Shelford Bidwell read a note on "*Hall's Effect in Tin*," in which he showed that a small extension and a greater extension produced opposite thermo-electric effects in tin wires.

In answer to Professor Guthrie and Mr. Walter Bailey, Professor Thompson stated that the change of resistance he had observed was sub-permanent, and died away in about half an hour. He believed it to be producible on the strip when no current traversed it.

Professor S. P. Thompson then read a Paper "*On some Propositions in Electro-magnetics*," giving a connected series of explanations throwing light on the laws of electro-magnetics, and based on a practical experiment.

ROYAL METEOROLOGICAL SOCIETY.

The usual monthly meeting of this Society was held on Wednesday evening, the 19th inst., at the Institution of Civil Engineers, Mr. R. H. Scott, F.R.S., President, in the chair. Messrs. W. Bailey, M.A., W. L. Blore, A. L. Ford, H. Leupold, A. F. Lindemann, F.R.A.S., and Rev. E. B. Smith were elected Fellows of the Society.

The President read a Paper entitled "*Brief Notes on the History of Thermometers*." He stated that the subject had been handled in a comprehensive manner by M. Renou a few years ago in the Annuaire of the French Meteorological Society, so that he should merely mention some of the leading points. The name of the actual inventor of the instrument is unknown. The earliest mention of it, as an instrument, then 50 years old, was in a work by Dr. R. Fludd, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiezometers, as the end of the tube was open and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were of course affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the Loan Collection of Scientific Apparatus at South Kensington in 1876. They are in the collection of the Florentine Academy, and in general principle of construction they are identical with modern thermometers. Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to Englishmen. Robert Hooke suggested the use of the freezing-point; Halley, the use of the boiling-point and the employment of mercury instead of spirit, and Newton was the first to mention blood-heat. Fahrenheit was a German by birth, but was a *protégé* of James I., and died in England. Réaumur's thermometer, in its final form, owes its origin to De Luc; while the centigrade thermometer, almost universally attributed to Celsius, was really invented by Linneus. Celsius's instrument had its scale the reverse way, the boiling-point being 0° and the freezing-point 100°. Mr. Scott then gave a brief account of some of the principal forms of self-registering and self-recording thermometers.

After the reading of this paper the meeting was adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the Exhibition of Thermometers and of Instruments recently invented. This Exhibition was a most interesting one and embraced 136 exhibits. The thermometers were classiffed as follows:—(1) Standard, (2) Maximum, (3) Minimum, (4) Combined Maximum and Minimum, (5) Metallic, (6) Self-recording, (7) Solar Radiation, (8) Sea, (9) Earth and Well, (10) Thermometers used for special purposes, (11) Thermometers with various forms of bulbs, scales, &c., and (12) Miscellaneous Thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, photographs, &c.

CORRESPONDENCE.

ON A HITHERTO UNNOTICED CONSTITUENT OF TOBACCO.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlix., p. 123, you published an abstract of my paper on "A hitherto unnoticed Constituent of Tobacco." I shall be obliged if you would insert the following remarks:—

The acid I found in tobacco is caffetanic acid, from which, by boiling with dilute hydrochloric acid, I obtained another acid, which I called tabaco-tannic acid. The latter body does not exist ready formed in tobacco. It does not give a green colouration with ammonia, but a fine red violet, a change which is due to oxidation. Its other reactions are equally distinct.—I am, &c.,

T. J. Savery, F.I.C.

25, Huntley Street, W.C.,
March 19, 1884.

A WARNING.

To the Editor of the Chemical News.

Sir,—Some time ago a German Swiss visited Dublin, asking for employment in a chemical laboratory, and as he was in apparent distress he obtained loans of money to enable him to go over to Glasgow. I have a specimen of his handwriting: the name which he gave me was Heinrich Valtier, and he represented himself as the son of Professor Carl Valtier, of Zürich. He promised to write to me on his arrival in Glasgow, but as I have not heard I am under the impression that he is probably the same person described by Mr. Henry S. Billing.—I am, &c.,

W. N. Hartley.

Royal College of Science for Ireland,
Stephen's Green, Dublin.
March 22, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 4, January 28, 1884.

Remarks on the Law of Faraday and on the Law discovered by M. Bouty.—M. Wurtz.—The author controverts the opinion of M. Berthelot that the interpretation of these laws becomes more obscure and more complicated if expressed by means of atomic weights as contradistinguished from equivalents.

The Dissemination, the Assimilation, and the Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—The proportion of phosphoric acid in

rocks varies from 3 per cent in lavas to a minimum of 2 per 1000 in certain granites and certain neocomian limestones. One of the most active agents in the decomposition of rocks, and their conversion into arable soil, is the attack of their surface by mosses and lichens. Without doubt the addition of soluble phosphate accompanied with organic matter is of great value, but the presence of organic matter is the capital point, and those who think they can dispense with it indulge in chimeras. The author gives the preference to the molybdic method for determining phosphoric acid in soils. He attacks the sample of earth in the moist way, with aqua regia or hydrochloric acid in excess. The liquid is treated with ammonia cautiously, so that the sesquioxides may be precipitated before the liquid shows an alkaline reaction. The solution is then saturated with ammonia and filtered. The sesquioxides collected on the filter retain absolutely the whole of the phosphoric acid. The precipitate is ignited for the first time along with the filter in a platinum crucible. The residue, reduced to an impalpable powder, is again ignited to white redness in a small platinum crucible. This powder is then digested with nitric acid diluted to one-fiftieth. The filtrate, after concentration on the water-bath, is precipitated with the molybdic solution. After twenty-four hours the whole is filtered, and after washing with the reagent the phospho-molybdate remains absolutely pure. It is then re-dissolved in ammonia, and is precipitated with magnesia mixture.

Reciprocal Action of Two Electrised Spheres.—M. Mascart.—A mathematical paper not capable of useful abstraction.

The Skrivanow Battery.—D. Monnier.

Variations of Electromotive Force in Accumulators.—E. Reynier.—In the three systems of accumulators studied—the lead, the copper, and the zinc amalgam—the secondary electromotive force is notably higher during the charge than during the discharge. The transitory super-elevation of the electromotive force augments with the intensity of the charging current and with the electromotive force of the source. In Planté's accumulator the electromotive force is at least 1·95 volts during the charge, and at most 1·85 volts during the discharge. The coefficient of decrease is, under the most favourable conditions, 0·95. In the copper accumulator this coefficient is 0·87, and in that of amalgamated zinc 0·983. In practice the losses will be always greater.

New Means of Preparing Barium Permanganate.—G. Rousseau and B. Bruneau.—The authors decompose a cold saturated solution of potassium permanganate with hydrofluo-silicic acid, filter through asbestos, and saturate the filtrate with milk of baryta. They think that most of the permanganates may be prepared in an analogous manner.

Nitrogenous Colloid derived from Amido-benzoic Acid.—E. Grimaux.—The author has succeeded in preparing a nitrogenous colloid substance, approaching the albumenoids in its reactions, and which furnishes solutions coagulable by heat. He dissolves in ammonia the white powder formed by the action of phosphorus perchloride upon amido-benzoic acid. This solution, which filters very slowly, is evaporated in a vacuum at common temperatures. It then forms at first a thick jelly, and then dries up into translucid, yellowish, scentless, and tasteless plates, resembling blood albumen. It swells up in cold water and gradually dissolves, but is readily soluble in hot water. It may be heated to 100° without losing its insolubility in water; but if it is evaporated on the water-bath the residue, though retaining the same appearance, is quite insoluble in water, though soluble in ammonia, the alkalies, and in sodium phosphate. Hydrochloric, nitric, tartaric, oxalic, and acetic acid precipitate it; acetic acid in excess slowly re-dissolves the precipitate formed at first, and the solution deposits flocks on the addition of potassium ferrocyanide. If lime-water is added to the solution of the colloid the solution remains limpid, but it has acquired the property of coagulating to a thick jelly by the action of heat. Rennet coagulates the solution of this artificial colloid in the same manner as caseine.

The Lutidine of Coal-Tar.—Oechsner de Coninck.—There is in coal-tar a lutidine identical with one of the utidines of Dippel's oil and with that which Ladenburg has lately formed synthetically, and which he considers as a γ-ethyl-pyridine.

No. 5, February 4, 1884.

Faraday's Law.—M. Berthelot.—The author contends that Faraday's law may be expressed in general terms more simply by means of equivalents than of atomic weights, and this as well for the electro-positive as the electro-negative elements.

Formation-Heat of Mercury Oxychlorides.—G. André.—This paper does not admit of useful abridgment.

Liquefaction of Hydrogen.—S. Wroblewski.—The author subjected hydrogen to a pressure of 100 atmospheres in a glass tube, arranged perpendicularly, of 2 m.m. external diameter, and of 0·2 to 0·4 m.m. internal diameter. By means of a screw the compressed gas can be released instantaneously. The tube was surrounded with liquid oxygen and refrigerated by means of a series of ebullitions of this body. At the moment of releasing the hydrogen there appeared in the tube an ebullition quite analogous to that observed by M. Cailletet in oxygen in his experiments in 1882. The phenomenon is produced in the same manner at a certain distance from the bottom of the tube. It lasts for a much shorter time is less decided and much less easy to perceive. The reason of this difficulty may perhaps be explained by the very low density of liquid hydrogen. MM. Cailletet and Hautefeuille in their researches on the densities of oxygen, hydrogen, and nitrogen liquefied in presence of a liquid without chemical action upon these elementary bodies, have inferred for liquid hydrogen the number 0·033. Since the same method yielded, under the same conditions, the number 0·89 for the density of oxygen, and since this latter number agrees entirely with the author's direct determinations, it may be admitted that the density assigned by MM. Cailletet and Hautefeuille for hydrogen will not be far from the truth. On the other hand, gaseous hydrogen reaches this same density, 0·033, at a low temperature, under inconsiderable pressures. Hence arises the optical difficulty of distinguishing the liquid from the gaseous portions of the hydrogen. This difficulty has probably prevented the author from reproducing M. Cailletet's experiment on hydrogen. The analogy between the phenomenon described and those presented by oxygen permits us to suppose that the temperature necessary for the complete liquefaction of hydrogen is not far from that which may be obtained by means of boiling oxygen.

MEETINGS FOR THE WEEK

MONDAY, Mar. 31st.—Medical, 8.30.
—— Society of Arts, 8. "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S.
TUESDAY, April 1st.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Royal Institution, 3. "Animal Heat," Prof. Gamgee.
—— Society of Arts, 8. "The Rivers Congo and Niger Entrances to Mid-Africa," by Robert Capper.
WEDNESDAY, 2nd.—Society of Arts, 8. "The Dwellings of the Poor of Great Cities," by Elijah Hoole.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 3rd.—Royal, 4.30.
—— Chemical, 8.
—— Royal Institution, 3. "The Older Electricity," by Prof. Tyndall.
FRIDAY, 4th.—Royal Institution, 8. "The Building of the Alps," by Prof. Bonney, at 9.
—— Geologists' Association.
SATURDAY, 5th.—Royal Institution, 3. "Photographic Action," by Capt. Abney.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1271.

ON THE USE OF MOIST ELECTRODES.

By W. N. HARTLEY, F.R.S.E., &c.
Professor of Chemistry, Royal College of Science, Dublin.

IN the CHEMICAL NEWS, vol. xlix., p. 117, I have observed a note by Prof. E. Wiedemann commenting upon the cause to which I assign the lengthening of metallic lines when spectra are taken from sparks passing between electrodes, one of which is partly immersed in water. He believes my explanation is not quite exact, and proposes one which I originally embodied in my paper, but rejected after twelve-months' consideration as on the whole unsatisfactory. The amount of oxy-hydrogen gas produced in the spark seems insufficient to make such changes in the spectra as I have noted. By heating the electrodes we lower the potential necessary to produce an intense spark, and by preventing them from becoming heated we prevent the potential from being lowered. Electrodes in air always become heated unless they are kept constantly moist or nearly immersed in some liquid such as a saline solution, water, or acid. As a rule, electrodes which are bad conductors become the hottest and yield the shortest lines, with least emissive power, as, for instance, iridium and platinum. It is the lines of iridium in which the lengthening is most remarkable when the electrodes are moistened.

SOME REMARKS ON THE DETERMINATION OF HARDNESS IN WATERS.

By HERBERT JACKSON.

HAVING had occasion some short time ago to examine a hard water which owed half its hardness to salts of magnesium, I noticed that the soap test applied in the usual way gave a result which differed very much from that obtained by the quantitative estimation of calcium and magnesium. A perfectly normal lather was obtained when soap had been added in quantities sufficient to neutralise 14° of hardness, whereas the water contained salts of calcium and magnesium equivalent, on Clark's scale, to a hardness of 27°.

Although I was aware that similar observations had been made before, I thought that it might be useful to determine the conditions under which the soap test could not be depended upon for reliable results.

I found with waters containing calcium or magnesium alone that, whenever salts of either of these metals were in solution in quantities sufficient to give 23° of hardness on Clark's scale, no dependence could be placed upon the results given by the soap test. In the case of waters containing salts of both calcium and magnesium I found that if the salts of the latter metal were in solution in quantities sufficient to give more than 10° of hardness, no evidence could be obtained of their presence so long as the salts of calcium in the same water exceeded 6°; in such a case a perfect and permanent lather was produced when soap had been added equivalent to 7° of hardness.

If any water be diluted so as to reduce the proportions of the salts of calcium and magnesium below those stated above, perfectly reliable results will of course be obtained.

Instead of dilution I found that heating the water to about 70° C. was sufficient to cause a complete reaction between the soap and the salts of calcium and magnesium, even if these were present in far larger quantities than any given here.

The experiments so far had all been made with a solution of Castile soap of the strength suggested by Mr. Wanklyn in his book on "Water Analysis." My attention was next directed to the use of any one of the compounds of which such a soap is composed. I commenced with sodium oleate, and found that by employing this substance in a moderately pure condition, perfectly reliable results could be obtained in very hard waters without the trouble of either diluting or heating. I was unable to try sodium stearate directly because of the slight solubility of this substance in cold water or dilute alcohol; but I found that a mixture of sodium oleate and stearate behaved in exactly the same manner as the Castile soap.

I am not prepared at present to state the exact reaction which takes place between salts of calcium and magnesium and a compound soap containing sodium oleate and stearate. I publish these results because I have not noticed anywhere the fact that some waters show a greater hardness with soap when their temperatures approach the boiling-point than they do at the average temperature of the air, it being, I believe, the ordinary impression that cold water wastes more soap than hot water before a good and useful lather can be obtained, whereas with very many waters the case is quite the reverse. Neither am I aware at present whether it is well known that the use of sodium oleate unmixed with sodium stearate dispenses with the process of dilution even in very hard waters.

HERDERITE, A CALCIUM AND GLUCINUM PHOSPHATE AND FLUORIDE.*

By J. B. MACKINTOSH, E.M.

A FEW weeks ago, Mr. W. E. Hidden, of Newark, N.J., brought me some specimens of a mineral from the topaz locality at Stoneham, Maine, which, from its crystallographic relations, and from its physical properties, he determined to be the rare mineral Herderite. A specific gravity determination and qualitative test for phosphorus confirmed his conclusion, and as the mineral had never been analysed quantitatively, I undertook to make the analysis.

Herderite is mentioned in all authorities as being an alumina, lime, phosphate, and fluoride, but the results of my analysis show that there is no alumina present, the mineral being a glucina, lime, phosphate, and fluoride, represented by the formula:—

$$(3CaO,P_2O_5+3GlO,P_2O_5+CaF_2+GlF_2).$$

The results obtained are:—

	Found.	Calculated for $(3CaO,P_2O_5+3GlO,P_2O_5+CaF_2+GlF_2)$
CaO	33·21	34·33
GlO	15·76	15·39
P_2O_5	44·31	43·53
F	11·32	11·64
	104·60	104·89
Less O ..	4·76	4·89
	99·84	100·00

The glucina was identified as such, both by its equivalent weight and by its reactions in the wet way when separated from the other constituents of the mineral.

These results are of interest as being the first recognised case of the occurrence of glucina in any other form of combination except silicates and aluminates.

If the original qualitative analysis of herderite was correct in respect to the presence of alumina, then this mineral will be a new species; the probability, however, is that the qualitative analyst was mistaken, and that this mineral is herderite.

Further details regarding this mineral will be found in *he American Journal of Science* for February, 1884.

* From the *School of Mines Quarterly*, Jan., 1884.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING FEBRUARY 29TH, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, March 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 29th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 175 samples of water, the whole were, without exception, clear, bright, and well filtered.

In respect to their degree of freedom from organic matter, the condition of the samples examined during the month has been on the whole excellent—and exceptionally so for the season of the year. In one sample only was the proportion of organic carbon at all excessive; while the mean amount afforded by the samples of Thames-derived water was 0·14 part in 100,000 parts of the water, corresponding to about two-tenths of a grain of organic matter in a gallon.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PREPARATION OF ZINC FREE FROM ARSENIC.

By F. STOLBA.

ZINC free from arsenic and almost free from iron can be readily obtained from the commercial metal by exposing it simultaneously to the action of sulphur and watery vapour in such a manner that these agents rise from the bottom of the crucible through the melted metal.

Burnt gypsum is mixed with a fourth of its weight of coarsely powdered sulphur, and the mixture is made up to a paste with the necessary quantity of water. Of this, balls are moulded about 5 centimetres in diameter, and fixed, when dry, to the end of wooden rods of sufficient length and strength, so that they remain fast. When dry, the balls are ready for use. They are then pressed down into the melted metal to the bottom of the crucible. Abundant fumes of sulphur and water are given off and cause an agitation in the melted metal, so that caution is necessary. When the agitation ceases the ball is withdrawn, the scum is removed from the surface and the operation is repeated as required. One kilo. of zinc may be advantageously treated at once. The zinc thus purified is quite free from arsenic, and contains very slight traces of iron. The lead is also much diminished.—*Berichte Bœhm. Gesell. Wissen.*

SEPARATION OF NICKEL FROM COBALT.

REFERENCE is made to the methods of Terreil (*Comptes Rendus*, lxii., p. 139), and G. Delvaux (*Comptes Rendus*, xcii., p. 723). G. Vortmann modifies Delvaux's method by using, as oxidising agent, sodium hypochlorite in place of permanganate. If an ammoniacal solution of cobalt containing sal-ammoniac is mixed with sodium hypochlorite, complete oxidation ensues, even in the cold in a short time. The solution becomes of a deep red, and on adding excess of water, no basic salt of cobalt is deposited. If the liquid is boiled, the oxidation is more rapid; in a few minutes the solution takes a deep reddish-yellow colour and contains the cobalt chiefly as a luteo-salt. On diluting with water and adding potassa-lye the liquid remains clear, even on standing for days, if merely cobalt is present. If it also contains nickel, there is formed in a few minutes a precipitate of nickelous hydroxide. In this manner even traces of nickel may be detected in cobalt salts, and inversely small quantities of cobalt may be recognised in presence of nickel. The ammoniacal solution of nickel salts in presence of very small traces of cobalt shows, after treatment with sodium hypochlorite, a distinct reddish-violet colour. If this cannot be recognised, the precipitate formed by potash-lye after dilution with water is filtered off, and the faint yellow colour is observed in the filtrate. If only extremely minute traces of cobalt are present the filtrate may be colourless, but if heated with a little ammonium sulphide it gives a black precipitate of cobalt sulphide.

It must be remembered that nickelous hydroxide is slightly soluble in ammonia even in presence of potash- or soda-lye. Therefore an excess of ammonia at the beginning of the process is to be avoided.—*Zeitschrift Anal. Chemie*.

THE DETERMINATION OF ORGANIC MATTER IN WATER, ACCORDING TO THE METHODS DEPENDING ON THE REDUCTION OF PERMANGANATE.

By Dr. A. R. LEEDS.

THE author raises the objection that the oxidation of organic matter at common temperatures is less energetic than at 100°; that the execution of the process is tedious, and that the distinction of the organic matter present into putrescent and non-putrescent, according to the time that they are exposed to the action of the permanganate is based on an arbitrary assumption which cannot be correct. It hss been proposed to prolong the time of action to 24 hours, but even after so prolonged reaction the decomposition of the organic matter is not complete, and no additional insight is obtained into its nature. Hence for the last five years the determination of the organic matter in water has been performed in the author's laboratory at a boiling-heat, and according to the Kübel-Tiemann method. He has recently subjected this method to a very careful re-examination.

It was first ascertained what was the influence of a prolongation of the time of boiling. One hundred c.c. of water were boiled with 10 c.c. sulphuric acid (1 : 3), and the same volume of permanganate for 5, 10, 15, and 20 minutes. In one case the action became constant at 15 minutes; but in all the others there was a continued increase. The same water was then tried by the Schulz-Trommsdorff method, using instead of sulphuric acid 1 c.c. of a 20 per cent soda-lye. Here also the action was progressive and the oxidation was less energetic than with sulphuric acid. Ordinary distilled water was then examined by both methods, and here also progressive decomposition took place. Special distilled water, free from ammonia, was next tried with corresponding results. Hence it appears that from 0·30 to 0·35 c.c. permanganate

of the strength employed are necessary, to give 100 c.c. of the purest distilled water the rose tint which serves as final indication. Hence Dr. Leeds concludes :—

1. The Kübel-Tiemann's process must be retained. The determinations must be performed exactly in the same manner, and the duration of the experiment must be exactly five minutes.

2. The results must be connected by deducting the quantity of permanganate consumed in a blank experiment with *pure* distilled water.—*Zeitschrift für Analytische Chemie.*

CONTRIBUTIONS TO AZOTOMETRY.

By CARL MOHR.

AMONG the many methods proposed for determining nitrogen in nitrates and manurial mixtures none has met with so much approval as the reduction process with ferrous chloride, and measurement of the nitric oxide gas, as recommended by Schlösing, Grandeau, and others. Schlösing collects the gas over mercury, and Grandeau over water. To prevent the liquid from re-ascending into the decomposition-flask Muntz passes a current of carbonic acid through the apparatus and absorbs it by the introduction of a small volume of strong soda-lye. This ingenious proposal greatly facilitates the operation, since the nitric oxide gas is evolved only very slowly from the ferrous solution, a prolonged gentle boiling of the liquid being required. Here the carbonic acid renders essential service and enables with ordinary care the operation to be completed without accident. This method has, however, one defect: the inside of the gas burette moistened with soda-lye becomes very soon encrusted with crystals of sodium carbonate, rendering it difficult or impossible to read off the volume of gas. The author, therefore, employs instead of mercury or water a soda-lye of specific gravity 1·2 to 1·25. A lye of this strength absorbs the carbonic acid completely, and does not deposit crystals of sodium carbonate upon the glass. The current of carbonic acid passing through the apparatus disappears more and more towards the end of the process by absorption until finally the volume of gas remains constant.

The manipulation of a gas burette with caustic soda is rather difficult. The author has therefore designed a burette with a glass tap and a small cylindrical funnel. The burette is filled by aspirating from above by means of a caoutchouc tube and the tap is then closed.

The author has also designed an azotometer for ammoniacal salts and their mixtures. If the salt to be examined is approximately pure a 2 per cent solution is prepared. Of manurial mixtures 5 or 10 grms. are taken to 100 c.c. A graduated pipette, holding 10 c.c. and fitted with a small glass tap and an efflux point, is filled with this solution. A decomposition flask holding 150 c.c. is charged with 50 c.c. of a solution of bromine in caustic soda; the flask is then closed with a caoutchouc stopper having two perforations, through one of which is inserted the above-mentioned pipette, whilst a gas-tube serving as outlet passes through the other. The latter is connected by means of a short caoutchouc tube with the gas-burette above described. The introduction of the caoutchouc tube is necessary, as, after the decomposition, the flask must be shaken in order to liberate the absorbed nitrogen. After fitting up the gas-burette and introducing the pipette the tap is opened cautiously and 10 c.c. are allowed to flow in drop by drop. The evolution of gas takes place quietly and without perceptible heat. After the 10 c.c. have thus run in the apparatus is well shaken.—*Zeitschrift Anal. Chemie.*

The Electric Light in France.—The sluices of the Scarpe at Douai, a stream which connects all the canals of the North to the Scheldt, are lighted up by electricity, so that the barges are no longer delayed at night.—*Cosmos les Mondes.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

NICKEL AND COBALT.

ON account of the close similarity of these metals to each other, their atomic weights, approximately if not actually identical, have received of late years much attention.

The first determinations, and the only ones up to 1852, were made by Rothhoff;† each with but a single experiment. For nickel 188 parts of the monoxide were dissolved in hydrochloric acid; the solution was evaporated to dryness, the residue was dissolved in water, and precipitated by silver nitrate. 718·2 parts of silver chloride were thus formed; whence Ni=58·925. The same process was applied also to cobalt, 269·2 parts of the oxide being found equivalent to 1029·9 of AgCl. Hence Co=58·817. These values are so nearly equal that their differences were naturally ascribable to experimental errors. They are, however, entitled to no special weight at present, since it cannot be certain from any evidence recorded that the oxide of either metal was absolutely free from traces of the other.

In 1852 Erdmann and Marchand‡ published some results, but without details, concerning the atomic weight of nickel. They reduced the oxide by heating in a current of hydrogen, and obtained values ranging from 58·2 to 58·6, when O=16. Their results were not very concordant, and the lowest was probably the best.

In 1856, incidentally to other work, Deville‖ found that 100 parts of pure metallic nickel yielded 262 of sulphate; whence Ni=59·15.

To none of the foregoing estimations can any importance now be attached. The modern discussion of the atomic weights under consideration began with the researches of Schneider§ in 1857. This chemist examined the oxalates of both metals, determining carbon by the combustion of the salts with copper oxide in a stream of dry air. The carbon dioxide thus formed was collected as usual in a potash bulb, which, in weighing, was counterpoised by a similar bulb, so as to eliminate errors due to the hygroscopic character of the glass. The metal in each oxalate was estimated, first by ignition in a stream of dry air, followed by intense heating in hydrogen. Pure nickel or cobalt was left behind in good condition for weighing. Four analyses of each oxalate were made, with the results given below. The nickel salt contained three molecules of water, and the cobalt salt two molecules :—

$NiC_2O_4.3H_2O$.

1·1945	grms. gave	0·528	grms. CO_2.	44·203	per cent.
2·5555	,,	1·12625	,,	44·072	,,
3·199	,,	1·408	,,	44·014	,,
5·020	,,	2·214	,,	44·104	,,

Mean 44·098 ± 0·027

The following percentages of nickel were found in this salt :—

29·107
29·082
29·066
29·082

Mean 29·084 ± 0·006

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† Cited by Berzelius. *Poggend. Annal.*, 8, 184. 1826.
‡ *Journ. f. Prakt. Chem.*, 55, 202. 1852.
‖ *Ann. Chim. Phys.*, (3), 46, 182. 1856.
§ *Poggend. Annal.*, 101, 387. 1857.

$CoC_2O_4.2H_2O$.

1·6355 grms.	gave	0·781 grms.	CO_2.	47·753 per cent
1·107	,,	0·5295	,,	47·832 ,,
2·309	,,	1·101	,,	47·683 ,,
3·007	,,	1·435	,,	47·722 ,,

Mean 47·7475 ± 0·0213

The following were the percentages found for cobalt :—

32·552
32·619
32·528
32·523

Mean 32·5555 ± 0·0149

In a later paper* Schneider also gives some results obtained with a nickel oxalate containing but two molecules of water. This gave him 47·605 per cent of CO_2, and the following percentages of nickel :—

31·4115
31·4038

Mean 31·4076 ± 0·0026

The conclusion at which Schneider arrived was, that the atomic weights of cobalt and nickel are not identical, being about 60 and 58 respectively. The percentages given above will be discussed at the end of this chapter in connection with all the other data relative to the constants in question.

The next chemist to take up the discussion of these atomic weights was Marignac, in 1857.† His original paper is not accessible to me, and I am therefore obliged to give only such features of it as I can get from abstracts and reviews. He worked with the chlorides and sulphates of nickel and cobalt, using apparently common gravimetric methods. The sulphates, taken as anhydrous, were first ignited to expel SO_2+O, after which the residues were heated with weighed amounts of lead silicate. The increase in weight was CO_2 or NiO respectively. The anhydrous chlorides were prepared from the hydrated salts by ignition in dry chlorine or hydrochloric acid. With cobalt, the monohydrated chloride, dried at 100°, was also employed. For nickel he gives the following values, referred probably to O=16, S=32, Ag=108, Cl=35·5 :—

From $NiSO_4$ .. .. .. Ni=58·4 to 59·0
,, $NiCl_2$ .. .. .. ,, 58·4 ,, 59·28

To cobalt these values are assigned :—

From $CoSO_4$ .. .. .. Co=58·64 to 58·76
,, $CoCl_2.H_2O$ .. .. ,, 58·84 ,, 59·02
,, $CoCl_2$.. .. .. .. ,, 58·72 ,, 59·02

That is, contrary to Schneider's view, the two atomic weights are approximately the same. The values for nickel, however, run a little lower than those for cobalt; a fact which is probably not without significance. Marignac criticises Schneider's earlier paper, holding that the nickel oxalate may have contained some free oxalic acid, and that the cobalt salt was possibly contaminated with carbonate or with basic compounds. In his later papers Schneider rejects these suggestions as unfounded, and in turn criticises Marignac. The purity of anhydrous $NiSO_4$ is not easy to guarantee, and, according to Schneider, the anhydrous chlorides of cobalt and nickel are liable to be contaminated with oxides. This is the case even when the chlorides are heated in chlorine, unless the gas is carefully freed from all traces of air and moisture.

Dumas's‡ determinations of the two atomic weights were made with the chlorides of nickel and cobalt. The pure metals were dissolved in aqua regia, the solutions were repeatedly evaporated to dryness, and the residual chlorides were ignited in dry hydrochloric acid gas. The last two estimations in the nickel series were made upon $NiCl_2$ formed by heating the spongy metal in pure chlorine. In the third column I give the $NiCl_2$ or $CoCl_2$, equivalent to 100 parts of silver :—

0·9123 grms.	$NiCl_2$=	1·515 grms.	Ag.	60·218
2·295	,,	3·8115	,,	60·212
3·290	,,	5·464	,,	60·212
1·830	,,	3·041	,,	60·178
3·001	,,	4·987	,,	60·176

Mean 60·1992 ± 0·0062

2·352 grms.	$CoCl_2$=	3·9035 grms.	Ag.	60·254
4·210	,,	6·990	,,	60·229
3·592	,,	5·960	,,	60·268
2·492	,,	4·1405	,,	60·186
4·2295	,,	7·0255	,,	60·202

Mean 60·2278 ± 0·011

These results give values for Co and Ni differing by less than a tenth of a unit; here, as elsewhere, the figure for Ni being a trifle the lower.

In 1863* the idea that nickel and cobalt have equal atomic weights was strengthened by the researches of Russell. He found that the black oxide of cobalt, by intense heating in an atmosphere of carbon dioxide, became converted into a brown monoxide of constant composition. The ordinary oxide of nickel, on the other hand, was shown to be convertible into a definite monoxide by simple heating over the blast lamp. The pure oxides of the two metals, thus obtained, were reduced by ignition in hydrogen, and their exact composition thus ascertained. Several samples of each oxide were taken, yielding the following percentages of metal.

NiO.

78·597	1st sample.
78·584	
78·608	
78·581	2nd sample.
78·589	
78·583	
78·616	3rd sample.
78·590	
78·588	
78·590	4th sample.
78·594	
78·597	
78·588	

Mean of all 78·593 ± 0·0018

CoO.

78·591	1st sample.
78·588	
78·550	
78·598	
78·614	
78·603	2nd sample.
78·591	
78·591	
78·588	3rd sample.
78·592	
78 597	4th sample.
78·598	
78·595	5th sample.
78·589	
78·596	

Mean of all 78·592 ± 0·0023

These percentages are practically identical, and lead to essentially the same mean value for each atomic weight.

In a later paper Russell† confirmed the foregoing results by a different process. He dissolved metallic nickel and

* *Poggend. Annal.*, 107, 616.
† *Jahresbericht*, 1857, 225. *Bibl. Univ. de Genève*, (nouv. s.,) 1, 373.
‡ *Ann. Chem. Pharm.*, 113, 25. 1860.

* *Journ. Chem. Soc.*, (2), 1, 51.
† *Ibid.*, (2), 7, 494. 1869.

cobalt in hydrochloric acid and measured the hydrogen evolved. Thus the ratio between the metal and the ultimate standard was fixed without the intervention of any other element. About two-tenths of a grm. of metal, or less, was taken in each experiment. 100 parts by weight of Co or Ni give the following weights of H, calculated from the volume of the latter :—

Ni.		*Co.*	
3·420		3·395	
3·418		3·398	1st sample.
3·416		3·397	
3·417	1st sample.	3·398	
3·412		3·403	
3·415		3·401	2nd sample.
3·416		3·401	
3·398		3·404	3rd sample.
3·409	2nd sample.	3·405	
3·404		3·410	4th sample.
3·401—3rd sample		3·407	
3·412			
3·408	4th sample.	3·4017	
3·410			
Mean of all 3·411 ± 0·001		Mean of all ± 0·0009	

A glance at the tabulated discussion which closes this chapter will show that these figures agree well with each other, and well with those found from the analyses of the oxides. The probable errors assigned in the hydrogen series may be a little too low, since they ought to be modified by the probable error of the weight of a unit volume of hydrogen. So insignificant a correction may, however, be neglected.

Some time after the publication of Russull's first paper, but before the appearence of his second, some other investigations were made known. Of these the first was by Sommaruga,* whose results, obtained by novel methods, closely confirmed those of Schneider and antagonised those of Dumas, Marignac, and Russell. The atomic weight of nickel Sommaruga deduced from analyses of the nickel potassium sulphate, $K_2Ni(SO_4)_2.6H_2O$, which, dried at 100°, has a perfectly definite composition. In this salt the sulphuric acid was determined in the usual way as barium sulphate, a process to which there are obvious objections. In the third column are given the quantities of the nickel salt proportional to 100 parts of $BaSO_4$:—

0·9798 grms.	gave	1·0462 grms.	$BaSO_4$.	93·653
1·0537	,,	1·1251	,,	93·654
1·0802	,,	1·1535	,,	93·645
1·1865	,,	1·2669	,,	93·654
3·2100	,,	3·4277	,,	93·649
3·2124	,,	3·4303	,,	93·648
			Mean	93·6505 ± 0·001

For cobalt Sommaruga used the purpureo-cobalt chloride of Gibbs and Genth. This salt, dried at 110°, is anhydrous and stable. Heated hotter, $CoCl_2$ remains. The latter, ignited in hydrogen, yields metallic cobalt. In every experiment the preliminary heating must be carried on cautiously until ammoniacal fumes no longer appear :—

0·6656 grms.	gave	0·1588 grm.	Co.	23·858 per cent.
1·0918	,,	0·2600	,,	23·814 ,,
0·9058	,,	0·2160	,,	23·846 ,,
1·5895	,,	0·3785	,,	23·813 ,,
2·9167	,,	0 6957	,,	23·847 ,,
1·8390	,,	0·4378	,,	23·806 ,,
2·5010	,,	0·5968	,,	23·808 ,,
			Mean	23·827 ± 0·006

Further along this series will be combined with a similar one by Lee. It may here be said that Sommaruga's paper was quickly followed by a critical essay from Schneider,† endorsing the former's work, and objecting to the results of Russell.

In 1867 still another new process for the estimation of these atomic weights was put forward by Winkler,‡ who determined the amount of gold which pure metallic nickel and cobalt could precipitate from a neutral solution of sodio-auric chloride. Experimentally, the method seems to be quite accurate; practically, it involves a knowledge of the defectively ascertained atomic weight of gold. In order to obtain pure cobalt Winkler prepared purpureo-cobalt chloride, which, having been four or five times recrystallised, was ignited in hydrogen. His nickel was repeatedly purified by precipitation with sodium hypochlorite. From material thus obtained pure nickel chloride was prepared, which, after sublimation in dry chlorine, was also reduced by hydrogen. 100 parts of gold are precipitated by the quantities of nickel and cobalt given in the third columns respectively. In the cobalt series I include one experiment by Weselsky, which was published by him in a paper presently to be cited :—

0·4360 grm. nickel	precipitated	0·9648	gold	45·191
0·4367	,,	0·9666	,,	45·179
0·5189	,,	1·1457	,,	45·291
0·6002	,,	1·3286	,,	45·175
			Mean	45·209 ± 0·019
0·5890 grm. cobalt	pptd.	1·3045	gold	45·151
0·3147	,,	0·6981	,,	45·080
0·5829	,,	1·2913	,,	45·141
0·5111	,,	1·1312	,,	45·182
0·5821	,,	1·2848	,,	45·307
0·559	,,	1·241	,,	45·044—Weselsky.
			Mean	45·151 ± 0·025

Weselsky's paper,‖ already cited, relates only to cobalt. He ignited the cobalticyanides of ammonium and of phenyl-ammonium in hydrogen, and from the determinations of cobalt thus made deduced its atomic weight. His results are as follows :—

0·7575 grm.	$(NH_4)_6Co_2Cy_{12}$	gave	0·166 Co	21·914 per cent
0·5143	,,		0·113 ,,	21·972 ,,
			Mean	21·943 ± 0·029
0·8529 grm.	$(C_6H_8N)_6Co_2Cy_{12}$	gave	0·1010 Co	11·842 p.c.
0·6112	,,		0·0723 ,,	11·829 ,,
0·7140	,,		0·0850 ,,	11·905 ,,
0·9420	,,		0·1120 ,,	11·890 ,,
			Mean	11·8665 ± 0·0124

Finally, we come to the work done by Lee§ in the laboratory of Wolcott Gibbs. Like Weselsky, Lee ignited certain cobalticyanides and nickelocyanides in hydrogen and determined the residual metal. The double cyanides chosen were those of strychnia and brucia; salts of very high molecular weight, in which the percentages of metal are relatively low. A series of experiments with purpureo-cobalt chloride was also carried out. In order to avoid admixture of carbon in the metallic residues, the salts were first ignited in air, and then in oxygen. Reduction by hydrogen followed. The salts were in each case covered by a porous septum of earthenware, through which the hydrogen diffused, and which served to prevent the mechanical carrying away of solid particles; furthermore, heat was applied from above. The results attained were very satisfactory, and assign to nickel and cobalt atomic weights varying from each other by about a unit; Ni being nearly 58, and Co about 59. The exact figures will appear later. The cobalt results agree remarkably

* *Sitzungsb. Wein. Akad.*, 54, 2, Abth., 50. 1866.

* *Poggend. Annal.*, 130, 310.
† *Zeit. Anal. Chem.*, 6, 18. 1867.
‡ *Ber. d. Deutsch. Chem. Gesell.*, 2, 592. 1868.
‖ *Am. Journ. Sci.*, (3), 2, 44. 1871.

well with those of Weselsky. The following are the percentages of metal found :—

In Brucia Nickelo-cyanide,
$Ni_3Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6.10H_2O$.

5·724
5·729
5·750
5·733
5·712
5·729

Mean .. 5·7295 ± 0·0034

In Strychnia Nickelo-cyanide,
$Ni_3Cy_{12}(C_{21}H_{22}N_2O_2)_6.8H_2O$.

6·607
6·613
6·589
6·607
6·561
6·595

Mean .. 6·595 ± 0·005

In Brucia Cobalti-cyanide,
$Co_2Cy_{12}(C_{23}H_{26}N_2O_4)_6.H_6.20H_2O$.

3·759
3·720
3·739
3·748
3·747
3·749

Mean .. 3·7437 ± 0·0036

In Strychnia Cobalti-cyanide,
$Co_2Cy_{12}(C_{21}H_{22}N_2O_2)_6.H_6.8H_2O$.

4·583
4·596
4·554
4·564
4·577
4·549

Mean .. 4·5705 ± 0·005

In Purpureo-cobalt Chloride,
$Co_2(NH_3)_{10}Cl_6$.

23·575
23·587
23·586
23·579
23·569
23·581

Mean .. 23·5795 ± 0·0019

The last series may be combined with Sommaruga's, thus :—

Sommaruga	23·827	± 0·006
Lee	23·5795	0·0019
General mean ..	23·6045	0·0018

In discussing the atomic weights of nickel and cobalt we may ignore the work of Rothhoff, Erdmann and Marchand, and Deville. That of Marignac must also be omitted for want of sufficient data. For nickel we have the following ratios. The probable error assigned in No. 4 is that of a single experiment in No. 2 :—

(1) Per cent of Ni in $NiC_2O_4.3H_2O$, 29·084 ±0·006
(2) ,, CO_2 from ,, 44·098 ±0·027
(3) ,, Ni in $NiC_2O_4.2H_2O$ 31·4076±0·0026
(4) ,, CO_2 from ,, 47·605 ±0·053
(5) ,, Ni in NiO, 78·593 ± 0·0018
(6) ,, Ni in brucia nickelo-cyanide, 5·7295 ±0·0034
(7) ,, Ni in strychnia nickelo-cyanide, 6·595 ±0·005
(8) $Ag : NiCl_2 :: 100 : 60·1992 \pm 0·0062$
(9) $Ni : H :: 100 : 3·411 \pm 0·001$
(10) $Au : Ni :: 100 : 45·209 \pm 0·019$
(11) $BaSO_4 : K_2Ni(SO_4)_2.6H_2O :: 100 : 93·6505 \pm 0·001$

Since the proportion of water in the oxalates is not an absolutely certain quantity, the data concerning such salts are best handled by employing the ratios between the carbon dioxide and the metal. Accordingly ratios (1) and (2) give a single value for Ni, and ratios (3) and (4) another. In all we have nine values for the atomic weight in question :—

From (1) and (2)	Ni = 57·907	± 0·0379
,, (3) and (4)	,, 57·926	0·0654
,, (6)	,, 57·884	0·0396
,, (7)	,, 57·947	0·0467
,, (11)	,, 58·170	0·0829
,, (5)	,, 58·607	0·0139
,, (9)	,, 58·634	0·0165
,, (8)	,, 58·899	0·0339
,, (10)	,, 59·120	0·0376
General mean ..	,, 58·547	0·0089

If O = 16 Ni = 58·682.

In the foregoing result it will be seen that the two sets of figures due to Russell receive very great weight. This is because the one set is referred directly to hydrogen, without the intervention of the probable error of any other element; while the second set involves only the atomic weight of oxygen, of which the probable error is small. As regards accuracy of methods, however, and certainty concerning the purity of material, Russell's work is no better than Schneider's, and probably inferior to Lee's. Now values one to five in the above table represent the tolerably concordant results of Schneider, Lee, and Sommaruga. They, combined by themselves, give a general mean of Ni = 57·928 ± 0·0215; or, if O = 16, of Ni = 58·062. This value, taking everything into account, I cannot but regard as more likely to prove correct than the larger mean deduced from all the ratios. At all events, the atomic weight of nickel needs further careful investigation.

For cobalt these ratios are available :—

(1) Per cent of Co in $CoC_2O_4.2H_2O$, 32·5555 ± 0·0149
(2) ,, CO_2 from ,, 47·7475 ± 0·0213
(3) ,, Co in CoO, 78·592 ± 0·0023
(4) ,, ,, purpureo-cobalt chloride, 23·6045 ± 0·0018
(5) ,, ,, phenylammonium cobalti-cyanide, 11·8665 ± 0·0124
(6) ,, ,, ammonium cobalti-cyanide, 21·943 ± 0·029
(7) ,, ,, brucia cobalti-cyanide, 3·7437 ± 0·0036
(8) ,, ,, strychnia cobalti-cyanide, 4·5705 ± 0·005
(9) $Ag : CoCl_2 :: 100 : 60·2278 \pm 0·11$
(10) $Co : H :: 100 : 3·4017 \pm 0·0009$
(11) $Au : Co :: 100 : 45·151 \pm 0·025$

Hence we have ten values for Co, as follows :—

From (1) and (2)	Co = 59·865	± 0·0394
,, (4)	,, 59·080	0·0152
,, (5)	,, 58·913	0·0628
,, (6)	,, 59·177	0·0816
,, (7)	,, 59·057	0·0581
,, (8)	,, 58·960	0·0708
,, (11)	,, 59·044	0·0436
,, (9)	,, 58·961	0·0392
,, (3)	,, 58·604	0·0145
,, (10)	,, 58·794	0·0162
General mean ..	,, 58·887	0·008

If O = 16, Co = 59·023.

The following additional note has been communicated by the author:—

Since this chapter was written the atomic weight of nickel has been re-determined by Baubigny.* Two calcinations of $NiSO_4$ gave a residue of NiO equal, in mean, to 48·280 per cent. Hence Ni=58·598; or, if SO_3=80, Ni=58·679.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.†

By F. W. PAVY, M.D., F.R.S.

(Continued from page 142.)

Situation of the Converting Principle in the Ruminant Animal.

This deserves special consideration. In the course of my experiments I tried the stomach (true or fourth) and intestine of the sheep, and was astonished to find that no conversion took place. I was at a loss to understand that a vegetable feeder like the ruminant should thus be unprovided with the converting principle existing even in the alimentary tract of the carnivorous animal. This led me to experiment with the other portions of the ruminant stomach, and the results at once showed that the sheep is exceptional only in the position in which the converting principle is to be found. Whilst absent in the fourth or true stomach and the intestine, it is present in the paunch, reticulum, and the many-plies or third stomach. It is really interesting to note that this condition of things should exist and stand so strictly in accord with what seems reasonable to look for under the altered circumstances. Instead of what is swallowed passing in at once into the stomach and thence into the intestine as ordinarily occurs, the disposition in the ruminant is such that the food when first swallowed passes into the paunch and reticulum. Here it is delayed for some time and a favourable position afforded for the absorption of a diffusible substance like glucose. From these two stomachs the food is then regurgitated into the mouth, and, after thorough comminution, swallowed a second time and conveyed to the many-plies [or third stomach. By the arrangement existing in this cavity with its numerous laminæ or folds disposed like the leaves of a book, an extensive surface is passed over by the comminuted food before the fourth or true stomach is reached. Thus the paunch, reticulu m, and many-plies are traversed by the food in such a manner that absorption of any glucose present is likely to occur before the true stomach is reached, and observation shows that the converting principle exists in the paunch,reticulum, and many-plies, and not in the true stomach and intestine as in non-ruminant animals.

Subjoined are results illustrative of what I have said:—

Experiment.—Portions of the four stomachs and the small intestine of a recently-killed sheep were taken for the experiment. Finely divided portions of each were placed in separate beakers, and about 50 cub. centims. of water added, and then 10 cub. centims. of a solution of grape sugar, containing 0·128 grm. glucose. The beakers were exposed side by side for two hours to a temperature of 120° F. (48·8° C.), and afterwards allowed to remain for eighteen hours at the ordinary temperature. The analyses were now conducted, and the following results obtained:—

Paunch.

Before sulphuric acid	.. .. ..	0·074 grm.
After „ „	.. .. ..	0·128 „

Second Stomach (reticulum).

Before sulphuric acid	.. .. ..	0·082 grm.
After „ „	.. .. ..	0·124 „

Third Stomach (many-plies).

Before sulphuric acid	.. .. ..	0·110 grm.
After „ „	.. .. ..	0·128 „

Fourth Stomach (reed or true stomach).

Before sulphuric acid	.. .. ..	0·124 grm.
After „ „	.. .. ..	0·130 „

Intestine.

Before sulphuric acid	.. .. ..	0·124 grm.
After „ „	.. .. ..	0·124 „

The Portal Blood after the Ingestion of Grape Sugar.

An examination of the portal blood after the introduction of glucose into the stomach of a fasting animal may be considered as furnishing evidence of what has actually taken place during life. The experiments I have previously referred to have shown that glucose is moved into a body of lower cupric oxide reducing power by the agency of certain parts of the alimentary tract. The power to produce the change has been shown to belong to certain parts of the alimentary tract, but something more is wanted to prove that such change actually occurs as a phenomenon of life. The mode or experimenting now under consideration supplies this proof. A solution of glucose is introduced into the stomach of a fasting animal, and the animal afterwards killed, and the portal blood which contains the products of absorption from the alimentary canal collected and examined. If glucose were absorbed unchanged glucose should be encountered in the portal blood, but observation, as will be seen by the experimental results adduced below, shows that instead of glucose a product of lower cupric oxide reducing power than maltose is present. Thus everything conspires to indicate that upon entering the system glucose is moved into a body of lower cupric oxide reducing power. Such must be spoken of as constituting the first step towards the assimilation or appropriation of this principle within the system. Subjoined are the details of four experiments, two upon the herbivorous and two upon the carnivorous animal.

Experiment.—One ounce (28 grms.) of grape sugar dissolved in three ounces (85 cub. centims.) of water was injected through a flexible tube passed down the œsophagus into the stomach of a rabbit which had not been fed for twenty-eight hours. One hour and a quarter afterwards the rabbit was killed, and the abdomen immediately opened, and the blood collected from portal vein. The blood was prepared for examination into the usual way by pouring it into spirit, and dealing with the alcoholic extract by evaporating off the spirit and treating the residue with sulphate of soda. The following are the results that were obtained expressed as parts per 1000:—

Portal Blood.

Before sulphuric acid	.. .. ..	2·222 per 1000.
After „ „	.. .. ..	5·444 „

Relation 40 to 100.

Experiment.—Half-an-ounce (14 grms.) of grape sugar dissolved in three ounces (85 cub. centims.) of water were injected into the stomach of a rabbit which had not been fed for twenty-four hours. The rabbit was killed at the end of half-an-hour, and the portal blood collected and analysed.

Portal Blood.

Before sulphuric acid	.. .. ..	1·700 per 1000
After „ „	.. .. ..	3·400 „

Relation 50 to 100.

Experiment.—500 grains (32 grms.) of grape sugar dissolved in one and a-half ounces (43 cub. centims.) of water were injected into the stomach of a dog which had not been fed for twenty-four hours. In twenty-five minutes time the dog was killed, the abdomen immediately opened, and the portal blood collected and analysed. Duplicate analyses for the sake of check were made, and the following are the figures that were yielded:—

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* *Compt. Rend.*, 97, 951.

† A Paper read before the Royal Society, Dec. 20th, 1883.

Portal Blood.

I. Before sulphuric acid .. .. .. 1·200 per 1000.
After " " .. .. .. 2·233 "
Relation 53·7 to 100.

II. Before sulphuric acid .. .. .. 1·200 per 1000.
After " " .. .. .. 2·200 "
Relation 54·5 to 100.

Experiment.—500 grains (32 grms.) of grape sugar dissolved in one ounce (28 cub. centims.) of water were injected into the stomach of a dog which had not been fed for twenty-four hours. The dog was killed at the end of twenty minutes, the abdomen immediately opened and the portal blood collected. The blood from the right ventricle was also collected, and both submitted to analysis. The right ventricular blood will be seen to have contained glucose, and in about the usual amount, viz., 0·5 per 1000.

Portal Blood.

Before sulphuric acid .. .. .. 0·866 per 1000.
After " " .. .. .. 1·666 "
Relation 51 to 100.

Right Ventricle Blood.

Before sulphuric acid .. .. .. 0·466 per 1000.
After " " .. .. .. 0·466 "

Extent of the Conversion of Glucose.

Reference to the preceding results will show that in the change which glucose undergoes it is moved not only as far as maltose, but into the position of considerably lower cupric oxide reducing dextrins. When a reducing power above 61 against 100 for glucose is presented, it may be that we have a mixture of maltose and glucose to deal with, although I have nothing absolutely before me to enable me to state that such is the case, for it may be possible that there are products with reducing power standing between maltose and glucose, just as there are products—the dextrins—with reducing powers below that of maltose.

The lowest point to which in my observations upon the alimentary tract I have yet noticed glucose to have been moved, is into a product with a cupric oxide reducing power of 40 as compared with glucose at 100.

In an experiment just performed a moderately strong solution of glucose was exposed in contact with a considerable quantity of the previously dried stomach of the rabbit to a temperature of 120° F. (48·8° C.). 50 cub. centims. of the liquid were removed for analysis at the end of one hour, and another 50 cub. centims. at the end of two hours; the two portions yielded on analysis identically the same figures, showing that the point attained represents the full amount of working power derivable from the active principle present, and that after an hour no further action was exerted. The figures stood as follows:—

Before sulphuric acid .. .. .. 0·082 grm.
After " " .. .. .. 0·188 "
Relation 43 to 100.

As I have stated, the dried stomach was here employed. The stomach may be inflated and dried and thus preserved for use. It is, necessary, however, that self-digestion should not have been allowed to advance after death. Unlike the active principle of digestion—pepsin—which does not undergo self-digestion, the active principle concerned in the transformation of glucose is susceptible of being destroyed by the agency of gastric digestion. At least so it appears from the results that have presented themselves to me.

Cane Sugar.

Cane sugar is characterised by possessing no cupric oxide reducing power and by becoming converted into glucose by boiling with sulphuric acid.

In all experiments with cane sugar it is necessary to see that the specimen employed gives no cupric oxide reducing action. Specimens often contain more or less of a cupric oxide reducing body as an impurity.

For the conversion of cane sugar and the products of the action of ferments upon it into glucose by boiling with sulphuric acid, a great difference in the length of time required exists from that required for all the other carbohydrates. A 2 per cent strength of acid is used as for the other carbohydrates, and appeal to observation has satisfied me that full conversion may be considered to have taken place after boiling for five minutes. In reality, under examination by quantitative determination a different length of time, I have noticed full conversion to have taken place before the expiration of three minutes. For the sake of absolute security, however, I allow in my experiments seven minutes. To this extent the boiling may be carried, but boiling for a longer time is liable to lead to the development of colour, which interferes with the subsequent titration with the ammoniated cupric test, and is therefore to be avoided. The colour may not have shown itself to any decided extent in the product on the completion of the boiling, but becomes apparent during the process of neutralisation preparatory to titration. This remark about the development of colour not only applies to cane sugar but to the products derived from it by the action of ferments.

In consequence of the development of colour, the use of the high-pressure boiler, which may be employed for the conversion into glucose of starch, starch dextrins, and starch maltose, and also the products derived from the transformation by fervent action of glucose, is inadmissible in experiments with cane sugar. As will be subsequently seen, lactin stands in the same position as cane sugar in requiring precautions to be taken to prevent the development of colour in the process of conversion into glucose by the action of sulphuric acid.

The Salivary and Pancreatic Ferments and Cane Sugar.

Under this head I have simply to state that in order to deal with the matter systematically, and not to take anything for granted, I have submitted cane sugar to the influence of contact, under suitable conditions, with the saliva and the pancreas of the cat, dog, and sheep, and have not found that evidence has been furnished of any change being induced.

(To be continued.)

NOTICES OF BOOKS.

Handbook of Patent Laws. By W. P. THOMPSON, C.E. Sixth Edition, revised. London: Stevens and Sons.

A NEW edition of this manual must be pronounced timely, in view of the recent changes both in patent law and patent procedure. As a matter of course we cannot notice this book without to some extent criticising the principal features of the new Act, which leaves very much to be desired.

The author's preface contains, in common with the recent Act, an unfortunate reference to the Statute of Monopolies. We say unfortunate because the very word "monopolies" throws the typical free-trader into such a state of excitement that he cannot be reasoned with. We believe the mere use of this word, in connection with patent-right and copy-right, explains many of the attacks which have been latterly directed against both. Mr. Thompson writes:—"In the reign of James I. the Statute of Monopolies abolished and made illegal for the future these exclusive privileges, with a single reservation in favour of patents for invention, granted to the inventor for a limited period 'for any new manufacture *within the realm.*'" Now it seems to us that the author would have done well to point out the radical difference between a monopoly and a patent for an invention. One of the highest legal authorities known, Sir E. Coke, defines a

monopoly as an exclusive privilege granted to some person or corporation to do something which was formerly free and open to all men. But the exclusive right of the patentee is, on the contrary, to do something which, prior to the invention, was out of the reach of all men. Hence the patentee, unlike the monopolist, does not deprive the public of any right which they had heretofore enjoyed. This consideration, surely, ought to appease the free-trader, unless he claims the right of trading freely with his neighbours' property. It may be interesting here to note that whilst in Britain patent-right and copy-right are denounced by free-traders as "relics of protectionism," international copy-right is opposed by American protectionists as a free-trade movement!

We must here call special attention to those words in the quotation from the "Statute of Monopolies" which we have italicised, "within the realm." These words, without going any further, seem to show that the fundamental idea of a patent, whether invented or imported, was its being worked, if at all, within the realm. Yet there are many scores of British patents, often of a very valuable character, held by aliens domiciled abroad who never had the least intention of working such patents on British ground, and have obtained them merely to prevent any other person from so working. Thus our patent-laws, originally designed to foster the introduction of new arts into the realm, are ingeniously made the means of keeping them out! By what process our courts have persuaded themselves that this perversion is in harmony with the dictates of common sense we are of course unable to divine. But it may be interesting to note that we are the only nation of industrial importance which allows its patent-law to be turned to such a use. This in Austria-Hungary, as may be seen in the manual before us, an invention must be practised in the empire within a year from date of patent. In Belgium a patent is annulled if it is worked abroad with the knowledge of the inventor, but not in Belgium. Brazil requires *bona fide* working within three years of grant to such an extent as "to supply the wants of the country at reasonable rates." In France the invention must be worked within two years. In Germany a three years limit is fixed, after which the patent is forfeited.

It is to be regretted that the Patent Act of last year does not contain some very distinct provision of a similar nature, since it is evident that this country has been a very serious loser by the exisiting practice. There is, indeed, a stipulation that the patentee is bound to grant licenses on "reasonable" terms if it appear that the patent is not being worked in the United Kingdom, but the penalty of refusal is even in this case not forfeiture.

A feature in the German patent law, which we might very advantageously have borrowed, is that foods, drinks, and medicines are not patentable. This provision would strike a death-blow at quackery and at certain forms of sophistication.

Another strange and indefensible peculiarity of the British patent law is that its action is confined to England, Scotland, Ireland, and the Channel Islands. Under the so-called "old law" prior to 1852, a patent obtained in England, though it did not cover Ireland and Scotland, yet could be extended to "all Her Majesty's dominions and plantations abroad." We have never seen or heard of any reason for the discontinuance of this extension. A mere stroke of the pen would last year have made the Act apply to India and the Crown Colonies, conferring an equal benefit upon English and colonial inventors. And we doubt not that the legislatures of Canada, Australia, and other such colonies would hail as a boon an Imperial patent law. It must be remembered that a Spanish patent covers Cuba, the Phillipines, the Canaries, &c., and that a French patent holds good in Algeria. To these short-comings in the new Act Mr. Thompson does not refer so far as we can perceive. His work, however, is a very clear and fair guide to the patent laws of most countries, and will prove of great use to patentees.

CORRESPONDENCE.

POTASSIUM TELLUROCYANATE.

To the Editor of the Chemical News.

Sir,—About two months ago some notes of mine on the separation of tellurium and selenium were sent to you in the hope that they might find a place in the Chemical News,* and in them I have called attention to the evidence there is of the existence of *potassium tellurocyanate*. This evidence is that tellurium, when heated with solution of potassium cyanide, dissolves to a slight extent in such a form as to be—like seleno-cyanate—precipitable by hydrochloric acid, but non-precipitable by air or by a hot alkaline solution of glucose. This observation is not in accordance with what is to be found in "Watts's Dictionary," the "Select Methods of Chemical Analysis," and other works of authority. The *Zeitschrift*, vol. i., to which Fresenius refers in his "Quantitative Analysis," for an abstract of H. Rose's analytical work on this subject, also makes no mention of *tellurocyanate*.

Assuming that my notes will have appeared in the Chemical News before this reaches you, I write to say that Dr. Divers has just observed and pointed out to me in Rose's "Quantitative Analyse Tinkener," that its distinguished author had nevertheless observed the fact noted by me, of the reaction of tellurium with potassium cyanide and hydrochloric acid, and had given the same explanation of it as I have done. The application of the sugar-test as a verification is still my own, however, and besides I hope that my notice of the hydrochloric reaction and its significance may be of service in bringing Rose's work before the attention of chemists again, since it appears to have been quite lost sight of by subsequent writers on the subject.—I am, &c.,

Masachika Shimosé.

Imperial Japanese College of Engineering, Tokio, February 8th, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 5, February 4, 1884.

Transformation of Glyoxal into Glycolic Acid.—M. de Forcrand.—The author has obtained glyoxal by the action of nitric acid upon aldehyd. The glyoxal is then converted into glycolic acid by the action of an excess of water at 150°.

Antimony Fluoride.—M. Guntz.—The fact that antimony fluoride is not like the majority of antimony salts decomposed by an excess of water, and can be re-crystallised from its solutions, induced the author to make a thermo-chemical study of this compound. The absorption of heat on dissolving antimony fluoride in water increases with dilution and tends towards −2 cal.

Transformation-Heat of Prismatic Antimony Oxide into the Octahedral Oxide.—M. Guntz.—The conversion of the octahedral into the prismatic oxide is attended with the liberation of +0·6 cal.

Case of Isomerism of Chloro-nitrised Camphor.—P. Cazeneuve.—The author described the normal chloro-nitrised compound in February, 1883, and at the same time obtained a body which he now proves to be an isomer. It is dextro-rotatory and very soluble in cold alcohol. The normal compound is lævo-rotatory, and dissolves very sparingly in cold alcohol.

* See Chemical News, vol. xlix., p. 26.

No. 6, February 11, 1884.

Note on Faraday's Law.—Ed. Wurtz.—The author argues that in the interpretation of Faraday's law it is not the notion of atomic weights which should intervene, but that of valence. The quantity of metals deposited at the negative pole in the electrolysis of polyvalent metals does not in any manner correspond with the equivalents ordinarily adopted.

Absolute Total Actinometer.—M. G. A. Hahn.—The author's apparatus consists substantially of a retort exposed to the sun, and connected with a condenser and receiver placed in the shade, but in the open air. Carbon disulphide is poured into the retort and a vacuum is made in the apparatus so that it may contain merely the vapour given off by the liquid. As long as the sky is overcast the liquid remains in the retort without distillation or condensation. As soon as the sun shines the carbon disulphide begins to boil and the liquid collected in the receiver in a unit of time is proportional to the quantity of solar heat received in the same time.

Summary of Strokes of Lightning recorded in France during the first Half Year of the Year 1883.—Communicated by the Postmaster General.—A series of tables which do not admit of abstraction.

The Law of Joule.—P. Garbe.—Whilst examining the relation between the nature of the radiations emitted by incandescent lamps, and the energy radiated by these lamps, the author has been led to a verification of Joule's law in the case of incandescent bodies. Whilst the electric work expended in a certain time was 430·94 cals., the heat received by the calorimeter in the same time was 430·71 cals.

Electric Conductibility of very Dilute Saline Solutions.—E. Bouty.—Referring to his former paper on the same subject (*Comptes Rendus*, xcviii., p. 140), the author has verified his conclusions at different temperatures, and finds that the conductibility of all the solutions studied is one and the same function of temperature. The relation of these conductibilities remains invariable when the temperature changes, and the law of equivalents established at 15° is found exact at every other temperature.

Liquefaction of Hydrogen.—K. Olszewski.—The author's latest experiments demonstrate that hydrogen when submitted to a pressure of 199 atmos. and cooled by oxygen boiling in vacuo (6 m.m. of mercury) does not show a meniscus, but, if suddenly released there appears a momentary ebullition, not lasting a second, and small colourless drops are projected into the upper part of the tube. This phenomenon is quite analogous to that observed by M. Cailletet in oxygen, cooled by ethylene (boiling under the atmospheric pressure), and submitted to a sudden release. The author concludes that the temperature of oxygen boiling in a vacuum is as insufficient for liquefying hydrogen, even under a considerable pressure, as is the temperature of ethylene boiling at atmospheric pressure for obtaining liquid oxygen in a static condition. It seems to him that the evaporation of liquid oxygen cannot give a temperature as low as that used in his experiments.

The Law of Thermic Substitution Constants.—D. Tommasi.—In opposition to M. Berthelot the author maintains that his law is applicable not only to the salts of lead and mercury, but also to all other soluble salts, as appears from a comparison of the calculated numbers with the experimental results.

Formation of Methyl Iodide and Methylene Iodide at the Expense of Iodoform.—P. Cazeneuve.—The most favourable conditions for the production of these compounds are as follows :—500 grms. of iron (reduced by hydrogen) are intimately mixed with an equal weight of finely powdered iodoform, and 200 grms. of water are then added. A gentle heat is applied, and 120 grms. are collected of a mixture comprising 40 grms. methyl iodide, and 80 grms. methylene iodide, which are easily separated by heating in a vacuum.

Monobromised Methyl-Chloroform.—L. Henry.—This compound is a colourless liquid, perfectly limpid, not affected by light, of a peculiar ethereal odour and a taste at once sweetish and pungent. Its density at 0° is 1·8839. It boils without decomposition under the ordinary pressure at 151° to 153°. Its vapour-density is 7·46, calculation giving 7·34. Under the action of caustic alkalies it loses 1 mol. of hydrochloric acid. It completes the β-series of chloruration of ethyl bromide.

Manufacture of Farm-Yard Manure.—P. P. Dehérain —The temperature in a dung-heap varies from 28° to 68° in different strata. The gases in the upper portion are carbonic acid and nitrogen; lower down the nitrogen diminishes, and the carbonic acid increases. At the bottom there are found merely carbonic acid and marsh-gas. The production of this latter gas is caused by an organised ferment, and ceases on the addition of chloroform. The rise of temperature is due to an oxidation of the organic matter by free oxygen.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bleach Processes.—Information is requested on two bleach processes—the one, Peter Thomas's patent permanganate and sulphuretted borax, and the other, Charles Tappan's paraffin soap process. Any information as to working, &c., will much oblige.—G. H. D.

MEETINGS FOR THE WEEK

MONDAY, April 7th.—Medical, 8.30.
—— Society of Chemical Industry, 8. Election of Local Committee. "Preliminary Note on certain By-products of the Pintsch Oil-Gas Manufacture, in relation to the question of the conditions under which Benzenes are formed," by Dr. Armstrong. "On the Estimation of Sulphurous Acid in its Compounds," by Messrs. Giles and Shearer. "Further Note on the Solidification of Liquid Oils," by Mr. W. J. Carpenter.
TUESDAY, 8th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Photographic, 8.
WEDNESDAY, 9th.—Microscopical, 8.

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1. Hybridism with reference to the Theory of Evolution. By J. W. Slater.
2. Daily Variations of the Strength of the Wind on Land and at Sea.
3. Half-hours with the Old Naturalists.
4. The Duke of Argyll's Reign of Law and Unity of Nature. By James Simson.
5. Scientific Nomenclature. By Frank Fernseed.
6. On Technical Education. By Robert Galloway, M.R.I.A.

Analyses of Books. Correspondence. Notes.

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CITY and GUILDS of LONDON INSTITUTE for the ADVANCEMENT of TECHNICAL EDUCATION.

TECHNOLOGICAL EXAMINATIONS, 1884.

Examinattons in Technology will take place at the different Provincial centres throughout the kingdom, on Wednesday evening, May 28th, 1884, at 7 o'clock.

Secretaries are informed that the latest date for sending in returns of candidates who wish to be examined in May next is Monday, April 28th, after which date no application can be received.

Individual candidates who are unable to arrange to be examined at a Provincial Science Centre can, on application to the Director and Secretary, be examined in London, at the Finsbury Technical College, Tabernacle Row, E.C.

The examinations will be held in 45 subjects.

A programme containing syllabus of each subject and last year's examination questions can be obtained from the Central Office of the Institute, Gresham College, London, E.C.

PHILIP MAGNUS, Director and Secretary.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1272.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

Introduction.

1. In March, 1881, I sent to the Royal Society a preliminary notice of some results I had obtained when working on the molecular discharge in high vacua.† When the spark from a good induction coil traverses a tube having a flat aluminium pole at each end, the appearance changes according to the degree of exhaustion. Supposing atmospheric air to be the gas under exhaustion, at a pressure of about 7 millims. a narrow black space is seen to separate the luminous glow and the aluminium pole connected with the negative pole of the induction coil. As the exhaustion proceeds this dark space increases in thickness, until, at a pressure of about 0·02 millim. (between 20 and 30 M.),‡ the dark spark has swollen out till it nearly fills the tube. The luminous cloud showing the presence of residual gas has almost disappeared, and the molecular discharge from the negative pole begins to excite phosphorescence on the glass where it strikes the side. There is great difference in the degree of exhaustion at which various substances begin to phosphoresce. Some refuse to glow until the exhaustion is so great that the vacuum is nearly non-conducting, whilst others begin to become luminous when the gauge is 5 or 10 millims. below the barometric level. The majority of bodies, however, do not phosphoresce till they are well within the negative dark space. This phosphorogenic phenomenon is at its maximum at about 1 M., and, unless otherwise stated, the experiments now about to be described were all tried at this high degree of exhaustion.

Under the influence of this discharge, which I have ventured to call radiant matter, a large number of substances emit phosphorescent light, some faintly and others with great intensity. On examining the emitted light in the spectroscope most bodies give a faint continuous spectrum, with a more or less decided concentration in one part of the spectrum, the superficial colour of the phosphorescing substance being governed by this preponderating emission in one or other part of the spectrum.

Sometimes, but more rarely, the spectrum of the phosphorescent light is discontinuous, and it is to bodies manifesting this phenomenon that my attention has been specially directed for some years past, considerable interest attaching to a solid body whose molecules vibrate in a few directions only, giving rise to spectrum lines or bands on a dark background.

The Citron Band Spectrum.

2. For a long time past I have been haunted by a bright citron-coloured band or line appearing in these phosphorescent spectra, sometimes as a sharp line, at others as a broader nebulous band, but having always a characteristic appearance and occurring uniformly in the same spot. This band I first saw in the summer of 1879, and from that date down to a comparatively short time ago all my efforts to clear up the mystery proved vain. By chemical means it was not difficult to effect a partial separation of a certain mineral or earthy body into two parts, one giving little or no citron band, the other giving one stronger than the original band; and by again treating this latter portion by appropriate chemical means, the citron band-forming body could frequently be still more concentrated; but further than this for a long time it seemed impossible to go. I soon came to the conclusion that the substance I was in search of was an earth, but on attempting to determine its chemical properties I was baffled. A more Proteus-like substance a chemist never had to deal with. In my preliminary note, above referred to, speaking of the possibility that some of these spectrum-forming bodies might be new chemical elements, I said—"The chemist must be on his guard against certain pitfalls which catch the unwary. I allude to the profound modification which the presence of fluorine, phosphorus, boron, &c., causes in the chemical reactions of many elements, and to the interfering action of a large quantity of one body on the chemical properties of another which may be present in small quantities."

3. This warning was not unnecessary. No Will-o'-the-Wisp ever led the unwary traveller into so many pitfalls and sloughs of despond as the hunt for this phantom band has entrapped me. I have started with a large quantity of substance which, from preliminary observations, promised to be a rich mine of the desired body, and have worked it up chemically to a certain point, when the citron band vanished, and could not be again detected in either precipitate or filtrate. Half a-dozen times in the last four years the research has been given up as hopeless, and only a feeling of humiliation at the thought of a chemist being beaten by any number of anomalies made me renew each time the attack. Likewise, the tedious character of the research made a long continuance of failures very disheartening. To perform a spectrum test, the body under examination must be put in a tube and exhausted to a very high point before the spectroscope can be brought to bear on it. Instead of a few minutes, many hours are occupied in each operation, and the tentative gropings in the dark, pre-eminently characteristic of this kind of research, have to be extended over a long period of time.

4. I soon found that the best way to bring out the band was to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness (10). The anhydrous sulphate thus left frequently showed the citron band in the radiant matter tube, when before this treatment the original substance showed nothing (75).

Examination of Calcium Compounds.

5. My first idea was that the band might be due to a compound of lime. Much chemical evidence tended to support this view. I have already explained that the chemical extraction was rendered very difficult by the fact of the citron band so frequently turning up both in the precipitate and the filtrate. By neglecting the portion showing least citron band, and separating all the elements present which gave little or none, I could generally concentrate the citron band into a solution which—according to our present knowledge of analytical chemistry—should contain little else than the earths, alkaline earths, and alkalies. Ammonia added to this solution would precipitate an earth (11, 14), and in the filtrate oxalic acid would precipitate an insoluble oxalate (7, 13).

The citron band hovered between these two precipitates, being sometimes stronger in one and sometimes in the other. It was also to be detected, but more faintly, in the residue left after evaporating to dryness and igniting the filtrate from the oxalate.

I frequently obtained no precipitate with ammonia, and then the oxalate gave the band brilliantly; and occasionally the ammonia precipitate when formed gave little or no citron band. I was, however, generally sure to find it in the insoluble oxalate, and sometimes it was very brilliant, being accompanied by two bright green bands and a fainter red band.

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

† *Proceedings of the Royal Society*, No. 213, 1881.

‡ M = one-millionth of an atmosphere.

6. At this time one of the minerals which showed the citron band most strongly was a phosphorescent apatite from Ireland; and knowing the difficulties of separating the last traces of phosphoric acid from the earths, I explained the foregoing facts by the presence of small quantities of phosphoric acid, which gave rise to the ammonia precipitate; the bulk of the citron body not being precipitated by ammonia, but coming down as oxalate; whilst a little of this oxalate would remain dissolved in the ammoniacal salts present, and so appear with the alkalies.

I tested this hypothesis in every imaginable way, by mixing small quantities of phosphoric acid with salts of lime and other earths, in the endeavour to imitate the conditions occurring in the native minerals, and so educe the citron band; but I was unable to get any precipitate giving the citron band when I started with materials which did not originally give it.

7. A sufficient quantity of precipitated oxalate (5) having in course of time been accumulated, I attempted its purification. It was ignited, dissolved in dilute hydrochloric acid, and rendered slightly alkaline with ammonia and ammonic sulphide. The liquid was boiled to a small bulk, keeping it alkaline, and was then set aside in a warm place: a slight flocculent precipitate formed. This was filtered, and the filtrate re-concentrated. The clear strong solution should now contain nothing but barium, strontium, and calcium, with traces of elements from previous groups which might be soluble in the precipitants employed or in the ammoniacal salts present (for we know that the word *insoluble* applied to a precipitate is not an absolute term, and in minute analysis allowance must be made not only for the slight solubility of precipitates in the reagents present, but also for the power possessed by most precipitates of carrying down with them traces of soluble metallic salts from solution). Besides these, it was possible that a hitherto unrecognised element might be present, to which the citron band was due. By the ordinary process of analysis I could, however, only detect the presence of calcium and strontium.

8. The concentrated ammoniacal solution was added to an excess of a boiling solution of ammonic sulphate, and the whole was set aside for twenty-four hours; the precipitate which had formed was filtered off and washed with a saturated solution of ammonic sulphate. The precipitate was found to consist of strontic sulphate. On testing this in a radiant matter tube the citron band was very decided, although much fainter than in the original oxalate. The filtrate was diluted largely, heated, and precipitated with a hot solution of ammonic oxalate; it was then allowed to stand for some time, when a bulky white calcic oxalate came down. This was filtered and washed. Tested in the radiant matter tube, after ignition and treatment with sulphuric acid, it gave the citron band, far exceeding in brightness the spectrum of the original oxalate.

9. So far all the chemical evidence went to show that the band-forming substance was calcium, and further tests tried with the purified oxalate confirmed this inference. Every analytical test to which it was subjected showed lime, and nothing but lime; all the salts which were prepared from it resembled those of lime, both physically and chemically; the flame spectrum gave the calcium lines with extraordinary purity and brilliancy; and finally, the atomic weight, taken with great care, came out almost the same as that for calcium, 39·9 as against Ca 40.

10. I now sought for the citron band amongst other calcium minerals. The preliminary testing was simple. The finely powdered mineral was moistened with strong sulphuric acid, the action being assisted by heat, and the mass was then raised to dull redness (4). It was then put into a radiant matter tube and the induction spark passed through after the exhaustion had been pushed to the required degree.

Treated in this manner most native compounds of lime gave the citron band. A perfectly clear and colourless crystal of Iceland spar converted into sulphate gave it strongly, native calcic phosphate less strongly, and a crystal of arragonite much more brightly. A stalactite of calcic carbonate from the Gibraltar caves gave the band almost as well as calcite, as also did cinnamon stone (lime alumina garnet), iron slag from a blast-furnace, commercial plaster-of-Paris, and most specimens of ordinary burnt lime.

The Citron Band not due to Calcium.

11. Evidence stronger than this in favour of the view that the citron band was an inherent characteristic of calcium could scarcely be; but, on the other hand, there was evidence equally conclusive that the band was not essential to calcium. The ammonia precipitate (5) sometimes gave the citron band with great strength and purity, and although I had not yet obtained this in quantities sufficient for a detailed examination, it was easy to decide that it contained no phosphoric, silicic, or boric acid, fluorine, or other body likely to cause the precipitation of lime in this group. This precipitate must therefore be an earth, and the more carefully I purified it from lime and other substances, the more brilliantly shone out the citron band, and the more intense became the green and red bands.

Another stubborn fact was this:—Starting with a lime compound which showed the citron band, I could always obtain a calcic oxalate which gave the band stronger than the original substance; but if I started with a lime compound which originally gave no citron band, I could never by any means, chemical or physical, constrain the lime or the earthy precipitate to yield a citron band.

12. Among the minerals tried was eudialyte, a silicate of zirconium, iron, calcium, and sodium, containing about 10 per cent of lime. No citron band could be detected on testing the original mineral or any of the constituents separated from it on analysis. This, and a lump of common whiting (levigated chalk), were for some time my only sources of lime which gave no citron band.

13. The only explanation that I could see for this anomaly was that the elusive citron band was caused by some element precipitated with the calcic oxalate, but present in a quantity too small to be detected by ordinary chemical means. I then thought that were I to fractionally precipitate the solution of lime, the band-forming body might be concentrated in one or the other portion. Accordingly the calcic oxalate (7, 8, 9) was ignited and dissolved in hydrochloric acid, and fractionally precipitated in three portions with ammonic oxalate, the first and third portions being comparatively small. They were dried, ignited with sulphuric acid, and tested in the radiant matter tube. All three portions showed the citron band, but the portion which came down first gave the band decidedly the strongest, and the third portion precipitated showed it weakest. This therefore pointed to a difference between calcium and the body sought for. The process, however, was not satisfactory, and I was driven to seek some other method.

14. A portion of an ammonia precipitate found to give the citron band very well (5, 11), was dissolved in dilute sulphuric acid, and the solution evaporated down. Crystals were formed which were difficultly soluble in hot water, but appeared more soluble than calcic sulphate.

A large quantity of the calcic oxalate (7, 8, 9) was ignited with sulphuric acid at a dull red heat, and the resulting calcic sulphate was finely ground and then boiled in a very small quantity of water—not sufficient to dissolve the one-hundredth part of it. The mass was thrown on a filter, and the small quantity of clear liquid which came through was precipitated with ammonic oxalate. The resulting white precipitate was ignited with sulphuric acid, and tested in the radiant matter tube. For the sake of comparison a portion of the calcic sulphate remaining on the filter was also put in a radiant matter tube. The sulphate from the aqueous extract gave the citron band far more brilliantly than the calcic sulphate from the filter. I found, however, that it was impossible, by any amount of washing or boiling out, to deprive the calcic sulphate of all power of giving the citron band, although it was possible in this way to weaken its intensity considerably.

(To be continued.)

ON THE

ESTIMATION OF CUPROUS CHLORIDE IN COPPER LIQUORS.

By S. G. RAWSON, F.C.S.

In Claudet's process for the extraction of silver from iron pyrites, the presence of any large amount of cuprous chloride in the copper liquors obtained by lixiviation of the calcined ores is very prejudicial. The reason is that the iodide of zinc solution, added for the precipitation of the silver, converts much of the cuprous chloride into cuprous iodide ($Cu_2Cl_2 + ZnI_2 = Cu_2I_2 + ZnCl_2$); and therefore, with an equal volume of solution, much silver is left unacted upon, to obtain which a great excess of zincic iodide over that calculated is requisite. The Cu_2Cl_2 is therefore always determined as a check upon the working of the plant and furnaces; a high temperature in the latter leading to its formation in increased quantities. Three methods for its estimation were examined, viz.—First, oxidation with potassic bichromate, ferricyanide of potassium being the indicator; but this cannot be depended on, owing to the green colour of the solution masking the final stages. Secondly, by means of the addition of potassic sulphocyanide, and causing the cloudiness produced to be removed by ferric chloride, the amount of ferric chloride run in being the measure of the cuprous chloride present. In this case, however, only small quantities of liquor can be used, and the disappearance of the cloudiness is not a sharp enough end-reaction. There only remained oxidation by potassic permanganate, and this with care gave much the best results. The ordinary composition of the copper liquor in grains per gallon, specific gravity = 1·22, temp. = 60° F., is—

Cupric chloride	5690·896
Cuprous chloride..	235·200
Sodic chloride	3797·205
Argentic chloride	3·454
Ferrous chloride	280·034
Hydrochloric acid	536·551
Zincic sulphate	1271·037
Calcic sulphate	139·400
Plumbic sulphate	24·221
Sodic sulphate	10221·563
Insoluble residue..	9·311
Water (by difference)	47791·128
	70000·000

The amount of ferrous chloride varies with the quantity and strength of the free hydrochloric acid, but for every-day work it will be sufficient to estimate it once a week.

The process depends on the fact that in presence of ferric chloride cuprous chloride is converted into cupric chloride, with formation of ferrous chloride; and the equation representing the reaction is—

$$Fe_2Cl_6 + Cu_2Cl_2 = 2CuCl_2 + 2FeCl_2.$$

The permanganate solution contained 300 grains of the salt in 30,000 grains of water, and was standardised against iron-wire containing 9·97 grains Fe per 10 grains of wire, and also against pure ferrous sulphate containing 10·04 grains Fe″ per 50 grains of ferrous sulphate. 5000 grains of water were used throughout. The amount of acid was varied in these experiments to see if any, and in that case how much, difference was caused by its presence in increased quantities, for, so far as I know, no results have appeared on this important point.

			Decems. $Mn_2O_6Ko_2$.
(1)	50 grains SO_2Feo'' + 100 grains	SO_2Ho_2 =	59·45
(2)	,, ,, 250 ,,		59·45
(3)	,, ,, 500 ,,		59·50
(4)	,, ,, 1000 ,,		59·50

Even when a solution identical with (3) was freely exposed to the air for an hour it was only slightly oxidised, amount required being 59·35 decems. With iron wire the results were:—

			Decems. $Mn_2O_6Ko_2$.
(1)	10 grns. (9·97) Fe + 250 grains	SO_2Ho_2 =	59·00
(2)	,, 500 ,,		59·05
(3)	,, 1000 ,,		59·05

Left in an open flask for thirty-six hours, No. (2) required as much as 58·50 decims., so that a slight interruption in the titration would probably not make much difference. Ten grains of iron wire were also dissolved in 500 grains of hydrochloric acid, but it was difficult to strike the mark within from $\frac{1}{2}$ to $\frac{3}{4}$ decem., as the colour faded very quickly, and the solution was such a deep yellow that the addition of a little more permanganate did not much change the tint. The times taken to effect solution, as well as the temperatures when titrated, were much varied with but slight differences in the results, though cold solutions were preferable to hot.

From the above figures, taking only the last two determinations in each series, 10·00 grains Fe = 59·275 decems. $Mn_2O_6Ko_2$.

∴ 1 decem. $Mn_2O_6Ko_2$ = 0·29823 grains Cu_2Cl_2.

∴ 10 grains Cu_2Cl_2 should require 33·55 decems. $Mn_2O_6Ko_2$

Cuprous chloride is very slightly soluble in water, though readily so in hydrochloric acid, and I find that if a certain quantity, say 10 grains, is placed in a flask, and there is added 5000 grains of water, and it is allowed to stand for a day or less, that all the chlorine passes into solution as $CuCl_2$, containing the merest trace of Cu_2Cl_2; whilst the residue, which is of a red colour, consists entirely of Cu_2O, the quantity of chlorine present being *nil*; thus—

$$2Cu_2Cl_2 + OH_2 = 2CuCl_2 + Cu_2O + H_2.$$

The amount of copper present in cuprous chloride is theoretically 64·14 per cent; but the mean of several determinations of the salt on which the experiments were made only gave 63·68 per cent, and certainly some of this copper was in the form of the higher chloride, equivalent to a loss of 0·072 grain cuprous chloride on the 10 grains invariably used. Other impurities amounted to 0·144 grain, and this, when added to the deficiency in the copper, equals, per ten grains of chloride, a loss of 0·21 grain Cu_2Cl_2, which represents 0·70 decim. of permanganate, and which therefore must be subtracted from the 33·55 decims. previously found. Therefore, 10 grains Cu_2Cl_2 should require 32·85 decims. of standard permanganate, and this is slightly too high, owing to the presence of the small quantity of cupric chloride detected. With 10 grs. of chloride and 5000 grains of water, the titration in every case being completed in five minutes, the burette readings in decims. were—

10 grains	Fe_2Cl_6 + 100	SO_2Ho_2	=	27·30
25	,, ,,	,,		29·45
50	,, ,,	,,		31·00
100	,, ,,	,,		31·50
10 grains	Fe_2Cl_6 + 250	SO_2Ho_2	=	27·25
25	,, ,,	,,		29 30
50	,, ,,	,,		31·25
100	,, ,,	,,		32·20
10 grains	Fe_2Cl_6 + 500	SO_2Ho_2	=	27·25
25	,, ,,	,,		29·25
50	,, ,,	,,		31·20
100	,, ,,	,,		32·10
10 grains	Fe_2Cl_6 + 1000	SO_2Ho_2	=	28·00
25	,, ,,	,,		30·90
50	,, ,,	,,		33·10
100	,, ,,	,,		33·50

50 grains Fe_2Cl_6 + 500 HCl = 31·70

It will be observed from these figures how steadily the number of decims. run in rose with the amounts of ferric chloride and sulphuric acid added. This is especially noticeable in the last series, and is owing to the fact that

in such strong solutions the sulphuric acid forms ferric sulphate, liberating the chlorine as hydrochloric acid, and thus aiding in the more rapid solution of the cuprous salt; and further, as shown below, the hydrochloric acid so formed interferes very seriously with the reactions in general. When there was not much ferric chloride the permanganate was low, because as soon as the greater portion was reduced to ferrous chloride, the remaining cuprous chloride could only act on the permanganate slowly, and required more time than the five minutes allowed; and, further, the smaller the proportion of ferric chloride the less readily, and in smaller amounts, would ferric sulphate and hydrochloric acid be produced. It is, of course, well known that chlorides are better absent from volumetric determinations in which permanganate is to be employed, but perhaps the following rough quantitative experiments on the rapidity with which different chlorides act may prove interesting.

Solutions were made up to the same volume, and with equal weights of sulphuric acid, and also a much weaker (1 decem.=0·0884 grain Cu_2Cl_2) permanganate solution was prepared. With the exception of a short interval in its midst twenty-four hours was the time taken:—

(1) 1250 grains OH_2+250 SO_2Ho_2=1·0 decems. $Mn_2O_6Ko_2$.
(2) 1250 grains OH_2+250 HCl=34·0 decems. $Mn_2O_6Ko_2$.
(3) 1000 grains OH_2+250 SO_2Ho_2+250lICl= 107·0 decems. $Mn_2O_6Ko_2$.
(4) 1250 grains OH_2+250 SO_2Ho_2+25$S_3O_6Fe_2O^{VI}$= 1·5 decems. $Mn_2O_6Ko_2$.
(5) 1250 grains OH_2+250 SO_2Ho_2+25Fe_2Cl_6= 47·0 decems. $Mn_2O_6Ko_2$.
(6) 1250 grains OH_2+250 SO_2Ho_2+25$CuCl_2$= 75·0 decems. $Mn_2O_6Ko_2$.

In No. 3 eighty decems. were run in at once, showing how rapid was the decomposition, and how great the error which might arise from the presence of a large quantity of free hydrochloric acid.

The colour possessed by No. 1 was that to which all the others were referred. At the expiration of this period, Nos. 1 and 4 were of a bright pink; No. 2, a light brownish pink; No. 3, a brownish pink; No. 5, brown but still pink; No. 6, a purplish blue.

They were then allowed to stand for another day, when No. 1 still retained its colour, but in a lesser degree; Nos. 2 and 3 were quite colourless and clear: No. 4 pink slightly tinged with brown; No. 5 brown; No. 6 an electric blue.

These experiments showed so clearly the superiority of ferric sulphate that it was used instead of ferric chloride, and the results—only a few of which I give—were more satisfactory, both as regards their concordance and the permanency of the colour, which in all the ferric chloride solutions had been very fleeting.

25	grains	$S_3O_6Fe_2O^{VI}$	+250 SO_2Ho_2	=29·70
50	,,	,,	,,	30·10
50	,,	,,	+500 SO_2Ho_2	=30·50
100	,,	,,	+250 SO_2Ho_2	=31·75
100	,,	,,	+500 SO_2Ho_2	=32·20
100	,,	,,	+1000 SO_2Ho_2	=32·30

The best way to dissolve the ferric salt is to add sulphuric acid to it until it is in a pasty condition, and then to mix it with cold water: on no account should this be boiling or even hot. Perhaps a useful strength is 9800 grains of water and 200 grains sulphuric acid per 1000 grains of sulphate, and it should be allowed to stand for some time before being used, as a slight sediment usually settles out. The addition of a little ferrous sulphate will render it much more soluble, but the solution must then be standardised once a day at least, and a measured quantity run into the copper liquor, owing to the presence of this ferrous salt.

Many tests were made of solutions to which cupric chloride had been added together with sodic sulphate and chloride, and the various other salts found in the normal copper liquors. There was, however, but little perceptible difference caused by the presence of these substances, except in the case of much free hydrochloric acid. Then the titration should be performed with some quickness, and should be considered as finished on the first appearance of the pink colour, for the solution will turn green again very rapidly, owing to the action of the acids on one another. It is on this account that I prefer ferric sulphate to ferric chloride (though Sutton recommends the latter), as the oxidising agent, to avoid as far as possible the disturbing influence which chlorides exert on the end-reaction of the permanganate. It also seems better that the sulphuric acid, which is obliged to be used (among other ways I tried to work, but quite unsuccessfully,—(1) without sulphuric acid, (2) with acetic acid, (3) with tartaric acid) should only be added when everything else is ready, and then in the smallest quantity, and that a large excess of ferric sulphate should be taken. None of the observations are quite as high as might be looked for, because of the difficulty of getting all the cuprous chloride into solution, which is certainly not attained in so short a time as five minutes. I adopted this time, however, as being about that which would be given in an ordinary laboratory, and in the copper liquors themselves this error on the low side would be compensated for in two ways, both because cuprous chloride is much more soluble in cupric chloride and hydrochloric acid than in water; and, secondly, because the action of the sulphuric acid on the chlorides and hydrochloric acid will also tend to raise the readings. In fact I should be disposed to say that, if anything, the amount of cuprous chloride found would be too high rather than too low.

St. Helens, Lancashire.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 156.)

Action of the Stomach and Intestine upon Cane Sugar.

THROUGH the researches of Bernard, cane sugar has been known to be susceptible of being changed in the digestive canal. The description given is that the small intestine contains a ferment which has the effect of converting cane sugar into glucose, and that this ferment does not exist elsewhere within the digestive system.

Such is the statement that I had before me in starting upon the enquiry about to be set forth. If the assertion were true that cane sugar is thus converted into glucose, it would conflict with what I have shown to occur in the case of glucose. That glucose should be moved into a lower cupric oxide reducing body, and cane sugar at the same time moved into glucose, certainly appears contradictory. I will proceed to show how the matter in reality stands.

The evidence upon which the assertion is grounded that cane sugar is converted into glucose by the action of a ferment contained in the small intestine is that a body is produced which reduces the oxide of copper. No further inquiry than that afforded by testing with the copper test was formerly adopted, but it is now manifest that more than this is required to show what the body produced really consists of. I have submitted the matter to a full investigation, and will bring forward the results obtained to speak for themselves. The order I shall adopt is first the consideration of where the capacity exists for effecting a transformation, and next the nature of the transformation that occurs.

As cane sugar exerts no reducing action upon the copper test, the development of a cupric oxide reducing

* A Paper read before the Royal Society, Dec. 20th, 1883.

body in the product of experiment suffices to show that a transformation has been effected. It is only for determining the nature of the cupric oxide reducing body produced that the necessity exists for putting into practice the treatment with sulphuric acid, and comparing the reducing power after with that before. In all my experiments, however, this has been done, but to put the matter forward in as simple a form as possible I will not introduce unnecessary figures.

The subjoined experimental evidence obtained from various animals shows in an unequivocal manner that a transformative power is possessed by the stomach as well as by the intestine. It is true the energy of the intestine is very much greater than that of the stomach. This will be seen from the quantitative determinations deduced. The transformative energy possessed by the intestine produces so strong an effect as to render itself readily susceptible of recognition through coarse quantitative testing, and thus it did not escape the notice of Bernard. The less degree of energy, however, possessed by the stomach became overlooked.

Experiment.—A solution of cane sugar was placed in the thoroughly-cleansed stomach of a recently-killed rabbit, and the stomach immersed in about 100 cub. centims. of water contained in a beaker. The beaker and its contents were then exposed for thirty minutes to a temperature of 120° F. (48·8° C.), and afterwards placed aside in the laboratory for twenty-four hours. Some of the water was taken from the beaker for analysis at the end of the thirty minutes, and the remainder analysed at the end of the twenty-four hours. The contents of the stomach were also removed at the end of the twenty-four hours, and subjected to analysis. Precisely the same procedure was adopted with the intestine, and here duplicate observations were conducted. The cupric oxide reducing power belonging to the several products was ascertained, and the subjoined figures show the respective amounts of glucose to which it was equivalent.

Stomach.

	Cupric oxide reducing power expressed as glucose.
Water in beaker after thirty mins. ..	Trace.
,, ,, twenty-four hrs.	0·084 grm.
Contents of stomach after ,, ,,	0·088 ,,

Intestine.

I. Water from beaker after thirty minutes	0·082 ,,
,, ,, 24 hours ..	0·400 ,,
Contents of intestine after ,, ...	0·500 ,,
II. Water from beaker after thirty minutes	0·082 ,,
,, ,, 24 hours. ..	0·262 ,,
Contents of intestine after ,, ...	0·832 ,,

Experiment.—Some of the scrapings from the mucous membrane of the cleansed stomach of a pig were boiled to destroy the ferment, and then mixed with 20 cub. centims. of cane sugar solution.

Some of the same scrapings without being boiled were mixed with the same quantity of the solution of cane sugar, and then exposed for one hour to a temperature of 120° F.

Scrapings from the mucous surface of the intestine were dealt with in a precisely similar manner.

The products were treated with sulphate of soda, and submitted to the usual process of analysis with the following results:—

Stomach.

	Cupric oxide reducing power expressed as glucose.
Portion boiled and 20 cub. centims. of cane sugar solution (=0·302 grm. glucose) added	0·000 grm.
Portion exposed one hour to 120° F. with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose)..	0·032 ,,

Intestine.

Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose) added	0·000 grm.
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose)	0·082 ,,

Experiment.—Scrapings from the mucous membrane of the cleansed stomach of a horse were mixed with water, so that they could be measured out for employment.

Three portions of 20 cub. centims. each were taken. The first was boiled, and then mixed with 20 cub. centims. of a solution of cane sugar, equivalent to 0·570 grm. of glucose. The second was at once mixed with 20 cub. centims. of the same solution of cane sugar, and then exposed for one hour to a temperature of 120° F. The third was mixed with 5 cub. centims. of the cane sugar solution, equivalent to 0·142 grm. of glucose, and likewise exposed for one hour to a temperature of 120° F.

A counterpart proceeding was carried out with the scrapings from the mucous membrane of the intestine of the same horse. The several products were treated with sulphate of soda, and subjected to quantitative analysis, with the following results:—

Stomach.

	Cupric oxide reducing power expressed as glucose.
Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) added..	0·000 grm.
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) ..	0·012 ,,
Portion exposed for one hour to 120° F., with 5 cub. centims. of a solutions of cane sugar (=0·142 grm. glucose) ..	0·012 ,,

Intestine.

Portion boiled, and 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) added..	0·000 ,,
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·570 grm. glucose) ..	0·200 ,,
Portion exposed for one hour to 120° F., with 20 cub. centims. of a solution of cane sugar (=0·142 grm. glucose) ..	0·118 ,,

Experiment.—Some scrapings from the mucous membrane of the cleansed stomach of a dog were mixed with 10 cub. centims. of a solution of cane sugar, containing cane sugar equivalent to 0·464 grm. of glucose, and exposed for eighteen hours to the ordinary temperature. A parallel proceeding was undertaken with the intestine.

The following are the results that were obtained:—

	Cupric oxide reducing power expressed as glucose.
Stomach with cane sugar solution (=0·464 grm. glucose) stood eighteen hours ..	0·010 grm.
Intestine with cane sugar solution (=0·464 grm. glucose) stood eighteen hours ..	0·226 ,,

Experiment.—The inner surface of the cleansed stomach of a recently killed cat was scraped off and mixed with water, so that measured quantities could be taken. The same was done with the intestine; varying quantities were then exposed as mentioned below, in contact with 5 cub. centims. of a solution of cane sugar, in which the amount of cane sugar present stood equivalent to 0·250 grm. of glucose. The subjoined figures show the results obtained. Although not mentioned in the details given in each case (as also in all the other experiments I have made) the product was titrated before and after sulphuric acid, and the result obtained after treatment with sulphuric acid showed

that the amount of carbohydrate present stood equivalent to 0·250 grm. of glucose, in accordance with the representation given of the amount of cane sugar present in the 5 cub. centims. of cane sugar solution used. This double determination furnishes an important check upon the accuracy of the individual results obtained.

	Cupric oxide reducing power expressed as glucose.
20 cub. centims. of stomach product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·020 grm.
40 cub. centims. of stomach product, with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·036 ,,
20 cub. centims. of intestinal product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·072 ,,
20 cub. centims. of intestinal product with 50 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F., and afterwards allowed to stand eighteen hours at ordinary temperature	0·190 ,,
40 cub. centims. of intestinal product with 5 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F.	0·138 ,,
60 cub. centims. of intestinal product with 50 cub. centims. of cane sugar solution (=0·250 grm. glucose) exposed for two hours to 120° F...	0·150 ,,

Condition in the Ruminant.

I have already adverted to the peculiarity in the position of the ferment in the digestive tract of the ruminant which acts upon grape sugar, and shown that whilst in other animals it is situated in the stomach and intestine, in the ruminant it is found in the paunch, reticulum, and many-plies, and not in the true stomach and intestine. With reference to cane sugar also, the conditions are different. The stomach in animals generally contains much less ferment than the intestine. In the ruminant the amount of ferment in the true stomach is still less. The great difference, however, is in the intestine. Whilst the intestine of the horse, pig, &c., possesses an energetic transformative influence over cane sugar, it is striking to notice in a parallel experiment with the sheep that practically almost no change is induced. It is in the parts of the stomach before the true stomach is reached that the capacity exists for exerting the change which cane sugar undergoes in the alimentary tract.

Experiment.—Portions of the cleansed paunch, reticulum, many-plies, and reed or true stomach of a sheep were minutely divided, and 10 grms. of each taken. After the addition of a little water they were respectively mixed with 5 cub. centims. of a solution of cane sugar containing an amount of cane sugar equivalent to 0·104 grm. of glucose. They were now exposed for two hours to a temperature of 120° F., and then prepared in the usual way for titration with the ammoniated cupric test.

Portions of sheep's intestine were also dealt with according to the details furnished below.

The subjoined figures show the results obtained :—

	Cupric oxide reducing power expressed as glucose.
Paunch with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 190° F.	0·086 grm.
Reticulum with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F.	0·020 ,,
Many-plies with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F.	0·068 grm.
Reed (true stomach) with 5 cub. centims. of a solution of cane sugar (=0·104 grm. glucose) exposed for two hours to 120° F..	0·016 ,,
Intestine with 10 cub. centims. of a solution of cane sugar (=0·208 grm. glucose) exposed for two hours to 120° F.	trace.
Intestine with 20 cub. centims. of a solution of cane sugar (=0·302 grm. glucose) stood eighteen hours at ordinary temperature	0·006 grm.
Intestine with 10 cub. centims. of a solution of cane sugar (=0·416 grm. glucose) exposed forty-five minutes to 120° F., and afterwards allowed to stand eighteen hours at the ordinary temperature.. ..	0·014 ,,

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

SELENIUM.

THE atomic weight of this element was first determined by Berzelius,† who, saturating 100 parts of selenium with chlorine, found that 179 of chloride were produced. Further on these figures will be combined with similar results by Dumas.

We may omit, as unimportant for present purposes, the analyses of alkaline selenates made by Mitscherlich and Nitzsch,‡ and pass on to the experiments published by Sacc‖ in 1847. This chemist resorted to a variety of methods, some of which gave good results, while others were unsatisfactory. First, he sought to establish the exact composition of SeO_2, both by synthesis and by analysis. The former plan, according to which he oxidised pure selenium by nitric acid, gave poor results; better figures were obtained upon reducing SeO_2 with ammonium bisulphite and hydrochloric acid, and determining the percentage of selenium set free :—

0·6800 grms.	SeO_2 gave	0·4828 grms.	Se.	71·000 per cent.
3·5227	,,	2·5047	,,	71·102 ,,
4·4870	,,	3·1930	,,	71·161 ,,

Mean 71·088 ± 0·032

In a similar manner Sacc also reduced barium selenite, and weighed the resulting mixture of barium sulphate and free selenium. This process gave discordant results, and a better method was found in calcining $BaSeO_3$ with sulphuric acid, and estimating the resulting quantity of $BaSO_4$. In the third column I give the amounts of $BaSO_4$ equivalent to 100 of $BaSeO_3$:—

0·5573 grm.	$BaSeO_3$ gave	0·4929	$BaSO_4$.	88·444
0·9942	,,	0·8797	,,	88·383
0·2351	,,	0·2080	,,	88·473
0·9747	,,	0·8621	,,	88·448

Mean 88·437 ± 0·013

Still other experiments were made with the selenites of silver and lead; but the figures were subject to such errors that they need no further discussion here.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1. 1826.
‡ *Ibid.*, 9, 623. 1827.
‖ *Ann. d. Chim. et d. Phys.*, (3), 21, 119.

A few years after Sacc's work was published, Erdmann and Marchand made with their usual care a series of experiments upon the atomic weight under consideration.* They analysed pure mercuric selenide, which had been repeatedly sublimed and was well crystallised. Their method of manipulation has already been described in the chapter upon mercury. These percentages of Hg in HgSe were found :—

71·726
71·731
71·741

Mean 71·7327 ± 0·003

The next determinations were made by Dumas,† who returned to the original method of Berzelius. Pure selenium was converted by dry chlorine into $SeCl_4$, and from the gain in weight the ratio between Se and Cl was easily deducible. I include Berzelius's single experiment, which I have already cited, and give in a third column the quantity of chlorine absorbed by 100 parts of selenium :—

1·709 grms.	Se absorb	3·049 Cl.	178·409
1·810	,,	3·219 ,,	177·845
1·679	,,	3·003 ,,	178·856
1·498	,,	2·688 ,,	179·439
1·944	,,	3·468 ,,	178·395
1·887	,,	3·382 ,,	179·226
1·935	,,	3·452 ,,	178·398
			179·000—Berzelius.

Mean 178·696 ± 0·125

The question may here be properly asked, whether it would be possible thus to form $SeCl_4$ and be certain of its absolute purity? A trace of oxychloride, if simultaneously formed, would increase the apparent atomic weight of selenium. In point of fact, this method gives a higher value for Se than any of the other processes which have been adopted, and that value has the largest probable error of any one in the entire series. A glance at the table which summarises the discussion at the end of this chapter will render this point sufficiently clear.

Latest of all, we come to the determinations made by Ekman and Pettersson.‡ They tried various methods of investigation, and finally decided upon the two following :—

First. Pure silver selenite, Ag_2SeO_3, was ignited, leaving behind metallic silver in the subjoined percentages :—

62·93
62·95
62·97
62·94
62·98
62·98
62·95

Mean 63·957 ± 0·005

Second. A warm aqueous solution of selenious acid was mixed with HCl, and reduced by a current of SO_2. The reduced Se was collected upon a glass filter, dried, and weighed. Percentages of Se in SeO_2 :—

71·199
71·185
71·193
71·187
71·191

Mean 71·191 ± 0·0016

This series, combined with that of Sacc, 71·088 ± 0·032, gives a general mean of 71·1907 ± 0·0016.

* *Journ. f. Prakt. Chem*, 55, 202. 1852.
† *Ann. Chem. Pharm.*, 113, 32. 1860.
‡ *Ber. d. Deutsch. Chem. Gesell.*, 9, 1270. 1876. Published in detail by the society at Upsala.

There are now five series of figures from which to deduce the atomic weight of selenium :—

(1). Per cent of Se in SeO_2, 71·1907 ± 0·0016
(2). $BaSeO_3 : BaSO_4 :: 100 : 88·437 \pm 0·013$
(3). Per cent of Hg in HgSe, 71·7327 ± 0·003
(4). $Se : SeCl_4 :: 100 : 178·696 \pm 0·125$
(5). Per cent of Ag in Ag_2SeO_3, 62·957 ± 0·005

From these we get the following values for selenium :—

From (1)	Se = 78·894	± 0·018
,, (2)	,, 78·362	0·053
,, (3)	,, 78·700	0·019
,, (4)	,, 79·174	0·064
,, (5)	,, 78·819	0·025
General mean ..	,, 78·797	0·011

If O = 16, Se = 78·978.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

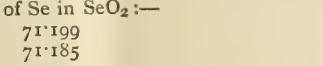
Anniversary Meeting, Monday, March 31, 1884.

THE PRESIDENT, Dr. W. H. PERKIN, F.R.S., read his annual report. The number of Fellows at the last Anniversary was 1247 : the present number is 1324, or an increase during the year of 77. The loss sustained by death has been exceptionally great, the following having died during the past twelve months :—R. R. F. Davey, W. Grant, W. Griffin, J. Hogarth, G. M. Hopwood, E. Hunt, C. H. Hutchinson, W. A. Peake, T. Pearsall, W. Plunkett, G. B. Robertson, Sir C. W. Siemens, F. Slinger, J. Hill Smith, W. Spottiswoode, J. T. Way, J. Young. The rooms of the Society have been re-decorated. Many additions have been made to the library, and it is hoped that the new catalogue will be completed by the end of the session. The collection of autotype portraits of Past Presidents is almost complete, and is on view in the Council room.

The PRESIDENT then handed the Longstaff Medal to Mr. O'Sullivan as the Fellow who, in the opinion of the Council, had done most to promote Chemical Science by research during the last three years.

Sixty-seven papers have been read before the Society since the last anniversary.

The PRESIDENT then referred briefly to some of the most important advances in chemical science during the year. The numerous determinations and re-calculations of atomic weights by Clarke, Lothar Meyer, Brauner, Thorpe, Dewar and Scott, &c. ; the use of boiling oxygen and ethylene as refrigerating media; the freezing of alcohol at −130°; the use of hydroxylamine as a reagent in organic chemistry, by Victor Meyer and his pupils; the improvements in the preparation of this substance by Divers, &c.; the numerous researches of Baeyer on the constitution of indigo, which may be represented—



(the President remarked that although there are now several processes by which this colouring matter can be manufactured, it cannot as yet be produced at a sufficiently low price to compete with the natural product); the work of Lewkowitsch on mandelic acid ; of Hofmann on pentamethyl-anilin; of Victor Meyer on thiophene, &c., were also briefly described.

The address concludes with some considerations as to the influence the increasing number of laboratories and the greater facilities for the study of chemistry have had on the development of chemical science in this country. The first thing that attracts attention is the startling and

anomalous fact that the number of papers read before the Society is declining year by year. In 1880-1 it was 113; in 1881-2, 87; in 1882-3, 70; and last year it was 67. The work of our laboratories at the Universities, Colleges, and Hospitals seems to consist mainly in studying the ordinary course of qualitative and quantitative analysis, and in attending one or two courses of lectures. Such an education is insufficient; it is only a preliminary part of the training. The subsequent prosecution of scientific research under proper supervision calls out all the faculties of the student, requiring independent thought, and gives an insight and vivid interest in the science which nothing else can do. In Germany the degree of Doctor of Philosophy has undoubtedly done much, as it necessitates the prosecution of original work; and now that degrees are so highly thought of in this country (though why a chemist with one of our ordinary degrees should be preferred to one who has fully given his mind to his science, and therefore has not such a degree, it is difficult to understand), it is believed that if something analogous to the Ph.D. degree could be inaugurated in this country it would help the further advance of chemical science in this country. It is said that students cannot be induced to stay longer than is necessary to go through the ordinary course of analysis, and can this be wondered at when they do not see anything else going on of sufficient interest to make them feel that it would be a great advantage for them to stay? Would it be the case if higher work were being enthusiastically carried on? The fact that many of our students leave this country for Germany, where research is carried on with so much zeal, is a sufficient answer to this question. In conclusion, the President expressed a hope that at the Central Institute of the City and Guilds of London chemists would be trained in such a way as not only to carry out existing processes, but also to advance the chemical industries of the country by suggesting improvements and new processes, so that these industries might flourish and at least keep abreast of those on the Continent.

Dr. GLADSTONE said that it was his agreeable duty to propose a vote of thanks to the President, and at the same time to move that his address, which had been so enthusiastically received, be printed.

The vote was seconded by Mr. HOWARD, and carried unanimously.

The TREASURER then read his report. The total income of the Society was £4732 16s. 4d. The expenses, including the purchase of £300 stock, amounted to £3028 1s. 9d., leaving a balance in the bank of £1704 14s. 7d. The balance was larger than had been anticipated, because an unusual number of Fellows elected during the year had paid life compositions, and because the new catalogue had not yet been completed. The principal items in the expenditure are—*Journal*, £1591; Library, £241; redecoration of rooms, £294; houses expenses, £185; commission, £145. The assets of the Society amount to £9792 14s. 7d. As to the Research Fund—Receipts amounted to £431; grants, £95; balance, £336; assets, £4836 3s. 3d.

Votes of thanks were proposed to the Treasurer, the Auditors, the Officers and Council, and the Editor, Sub-Editor, and Abstractors.

After a ballot the Scrutineers, Messrs. Greenaway and Williams, declared the following Officers and Council duly elected:—

President—W. H. Perkin, Ph.D., F.R.S.

Vice-Presidents—Sir F. A. Abel, Warren De la Rue, E. Frankland, J. H. Gilbert, J. H. Gladstone, A. W. Hofmann, W. Odling, Sir Lyon Playfair, H. E. Roscoe, A. W. Williamson, P. Griess, G. D. Liveing, E. Schunck, T. E. Thorpe, A. Voelcker, W. Weldon.

Secretaries—H. E. Armstrong, J. Millar Thomson.

Foreign Secretary—H. Müller.

Treasurer—W. J. Russell.

Members of Council—E Atkinson, H. T. Brown, T. Carnelly, M. Carteighe, R. J. Friswell, W. R. E. Hodgkinson, D. Howard, F. R. Japp, R. Meldola, R. Messel, C. O'Sullivan, C. Schorlemmer.

Ordinary Meeting, Thursday, April 3, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—R. St. Stephens and R. C. Tresidder.

Prof. P. T. Clève, of Upsala, was present at the meeting, and was formally admitted as a Foreign Member.

Mr. SALAMON read a paper "*On the Influence of certain Phosphates upon Vinous Fermentation*," by A. G. SALAMON and W. DE VERE MATHEW. Considerable difficulty is often experienced in the course of the manufacture of beer by the method of high fermentation in producing a sufficient attenuation of the wort in a given time. Under such circumstances it is constantly urged that the addition of certain salts of phosphoric acid will exercise such a stimulating influence upon the growth of the yeast organism as to materially increase the rapidity of the attenuation of the wort. The authors undertook the present series of experiments to determine whether such a stimulation is really obtained. They have estimated the vigour of the fermentation by the amount of sugar consumed in a given time, the sugar left after the fermentation being determined gravimetrically, as recommended by O'Sullivan. The following Pasteur solution was used as a fermenting medium:—Water, 100 c.c.; potassium phosphate, 0·233 gramme; calcium phosphate, 0·02 grm.; magnesium sulphate, 0·023 grm.; ammonium tartrate, 1·166 grm.; cane-sugar, 17·490 grms. The temperature of the solutions was maintained at 60° F., and the duration of the experiments was usually 60 hours. The following may be given as an example of the experiments. 100 c.c. of Pasteur solution were used with 5 grms. of pressed yeast:—

Sugar consumed in grammes per 100 c.c.	Potassium Phosphate in grammes per 100 c.c.
8·5770	0·0000
8·5896	0·0575
8·5001	0·1150
8·7666	0·1720
9·6884	0·2300 (=0·0770 P_2O_5)
9·9124	0·2875
7·7586	0·3450
7·5948	0·4025
7·8878	0·4600
7·2850	0·5175

Time, forty-eight hours.

It is seen that the maximum fermentation occurs when 0·23 grm. of potassium phosphate are present per 100 c.c., which is the normal amount in Pasteur's solution; a larger quantity is obviously fatal to the proper activity of the yeast ferment. Similar experiments proved that although small quantities of calcium and magnesium phosphates were beneficial an excess was most injurious. Now the normal amount of P_2O_5 in an English beer wort is about 0·1160 grms., and in the normal Pasteur solution 0·0875. The ordinary wort contains, therefore, an excess of P_2O_5 over that which has been found to be most favourable to fermentation. Hence it follows that it is not advisable to add phosphates for the purpose of accelerating the attenuation of ordinary beer worts.

The PRESIDENT asked if the authors had made any experiments to decide whether the alteration in activity was due to the potassium salts or the phosphoric acid.

Mr. WARINGTON said that in the tables where the authors had stated the phosphoric acid as 0·00 grm. the P_2O_5 in the yeast still had to be taken into account, because probably if no P_2O_5 were present no yeast growth or transformation of sugar would take place. It seemed that it was not at all proved that the action was due to the phosphoric acid. It would be interesting to know what

would happen if another salt, as potassium sulphate, was substituted for potassium phosphate.

Mr. Salamon said that their object was to ascertain whether it was advisable to add phosphates to the wort or not, and from their experiments it seemed that this question must be answered in the negative.

The Secretary then read a paper "*On the Occurrence of Rhabdophane in the United States*," by W. N. Hartley. In the *American Journal of Science*, xxv., 459, Brush and Penfield describe a new mineral from Salisbury, Conn., under the name of Scovillite. This mineral agrees in physical properties, &c., with rhabdophane (*Chem. Soc. Jour. Trans.*, xli., 210), and seems to be a variety of that mineral, containing erbium and yttrium, associated with lanthanium carbonate. In a subsequent number of the *American Journal of Science* (March, 1884) Brush and Penfield have recognised this identity of scovellite with Rhabdophane.

The Society then adjourned to April 17, when a paper "On the Synthesis of Galena," by Emerson Reynolds, will be read.

CORRESPONDENCE.

AN IMPOSTOR.]

To the Editor of the Chemical News.

Sir,—Professor Hartley's warning given in the Chemical News, vol. xlix., p. 147, reminds me of a visit paid to me by a German representing himself as the son of Dr. C. R. Fresenius, of Wiesbaden, some few weeks since. His story was to the effect that he was taking a holiday in this country, and had recently been the guest of Professor Roscoe, who had shown him many kind attentions. Upon his arrival in town he found that his only personal acquaintance here, viz , Dr. A. W. Williamson, was absent, and being temporarily inconvenienced by the non-arrival of an expected remittance from home, he appealed to me, with profuse apologies, for what must, he said, appear somewhat extraordinary conduct, to relieve him from his difficulty, which, by the way, was extremely well devised and effectively explained. Instead of discharging any obligation he may be under to me, he has no doubt passed on to new fields of action.—I am, &c.,

C. T. Kingzett.

Trevena, Amhurst Park, N.
April 4, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 7, February 18, 1884.

The President announced the loss sustained by the Academy by the decease of Count Theodor du Moncel, which took place on February 16th.

Reciprocal Displacements between Hydrofluoric Acid and the other Acids.—MM. Berthelot and Guntz. If a current of dry gaseous hydrochloric acid is passed in the cold into dry potassium fluoride contained in a platinum boat, the hydrochloric acid is absorbed without an escape of hydrofluoric acid, and there are formed potassium chloride and fluorhydrated potassium fluoride. With the nitric and sulphuric acids the results are similar. Hydrofluoric acid is partially expelled by acetic acid and also by oxalic and tartaric. All these facts are foreseen and explained on thermo-chemical principles.

Law of Modules, or Thermic Substitution-Constants.—M. Berthelot.—The author shows that this law does not hold good for the soluble salts of mercury.

On Fluorhydrated Potassium Fluoride and on its States of Equilibrium in Solutions.—M. Guntz.—This thermo-chemical memoir does not admit of useful abstraction.

Nitro-Derivatives of Ethylene Hydride.—M. A. Villiers. The author has previously described a first reduction-derivative of the potassium compound of tetranitrous ethylene bromide obtained by treatment with ammonium hydrosulphate. He has pursued the reductive action of hydrogen sulphide further, and has obtained a well-defined base, which he has not yet found opportunity to analyse. He has also studied the action of sulphurous acid upon the potassium compound of tetra-nitrous ethylene bromide.

Probable Number of Homologues and Isomeric Rosanilines.—MM. A. Rosenstiehl and M. Gerber.—From the experimental data furnished by M. Hofmann and the authors they conclude that nine rosanilines have been prepared, six homologues and three isomers. This number, however, they consider is but a fraction of those whose existence may be foreseen, and which probably amount to thirty.

New Compound obtained whilst Preparing Benzine Hexachloride.—J. Meunier.—The new compound has the same percentage composition as the ordinary benzine hexachloride. It forms octahedral crystals, which melt only at about 300°. Potassium cyanide dissolved in alcohol splits up the ordinary hexachloride but leaves the new compound untouched.

Constitution of Milk.—E. Duclaux.—The author, instead of the present methods of determining albumen and lactoproteine proposes to determine the caseine which passes through (unglazed) porcelain, and to which he gives the name of dissolved caseine in contradistinction to suspended caseine. He separates the soluble caseine from the two other forms by aspirating the milk through porous battery cells, selecting the smallest and the most homogeneous. The fatty matter, the two other forms of caseine, and a part of the calcium phosphate are left behind, whilst the milk-sugar, the dissolved caseine, and residue of the calcium phosphate and the other mineral salts pass through the porous material.

No. 8, February 25, 1884.

Equilibria between Hydrochloric and Hydrofluoric Acids.—MM. Berthelot and Guntz.—These two acids may displace each other reciprocally in consequence of the formation of fluorhydrates of the fluorides, both in the anhydrous and in the hydrated condition. This salt is partially dissociated by the water which dissolves it, the real proportions of acid and of fluoride combined varying according to the relative excess of the two components. They show that the various degrees of dissociation of the fluorhydrate regulate the equilibria between the two hydracids themselves. All this demonstration is the same which has been given by M. Berthelot for the reciprocal displacements, and the equilibria between sulphuric and hydrochloric acids. (See *Essai de Mécanique Chimique*, vol. ii., p. 638.

On the Reduction of the Congelation Point of Solutions of the Alkaline Salts.—F. M. Raoult.—In the author's tables of results the salts have been divided into five groups according to the number of atoms of metal contained in each saline molecule. The different salts in each group present approximately the same molecular lowering of the point of congelation.

Formation-Heat of the Mercury Oxybromides.—G. Andre.—The formation-heat of the mercury oxybromides is a little inferior to that of the corresponding compounds of lead and equally inferior to that of the mercury oxybromides of the same formula.

Determination of the Carbonic Acid of the Air effected by the Expedition to Cape Horn.—MM. A. Muntz and E. Aubin.—A description of the method of operation and a figure of the apparatus employed. It appears from the results obtained that at Cape Horn the proportions of carbonic acid in the air are very distinctly lower than those observed in Europe. The general mean of the observations is 2·56 of carbonic acid in 10,000 vols. of air, whilst the mean of determinations made in the northern hemisphere, at stations respectively remote from each other, is 2·84.

Formation-Heat of Antimony Chloride and Oxychlorides.—M. Guntz.—For the chloride the author adopts the value + 47·4 cal. For the oxychloride, SbO_2Cl, + 19·33 cal.

Synthesis of the Pyridic and Piperidic Bases.—A. Ladenburg.—The bases of the pyridic series are tertiary bases. They combine with the alcoholic iodides to form quaternary iodides. If these iodides are heated to 290° they are partially transformed into tertiary bases homologues of the pyridine employed. By this reaction there are always obtained two isomeric bases, one of which, the larger in quantity, belongs to the series γ, whilst the other, with a higher boiling-point, belongs probably to the series α.

Addition of Iodine Chloride to Monochlorated Ethylene.—L. Henry.—Monochlorated ethylene is absorbed more slowly than ethylene itself by the aqueous solution of iodine chloride. The resulting product falls to the bottom of the liquid as a slightly brownish oil, $C_2H_3Cl_2I$. Its spec. grav. at 0° = 2·2187; it boils under a pressure of 774 m.m. at 171° to 172°, taking a slightly violet colour.

A New Splitting-up of Ethyl Carbamate.—G. Arth.—The author finds that the reaction observed by M. Haller (*Comptes Rendus*, xcii, p. 1511, and xciv., p. 869), is general, and that all the carbamic ethers can be split up in a similar manner.

Ethyl and Ethyl Methyl-acetyl-cyanacetate.—A. Held.—The new compound is a colourless liquid of an ethereal odour, insoluble in water and alkalies, of spec. grav. 0·996 at + 20°, and boiling at 90° to 95° under a pressure of 15 to 20 m.m.

Action of Bromated Ethylene upon Benzol in presence of Aluminium Chloride.—MM. Hanriot and Guilbert.—The two products obtained by this reaction are styrolyle bromide and di-ethylbenzol dibromide.

Action of Rennet upon Milk.—E. Dulaux.—In spite of the addition of rennet, a part of the colloidal caseine of the milk, 0·46 per cent, does not change its condition and does not, like the rest, pass into the form of solid caseine. The portion remaining untouched diminishes if the dose of rennet increases, but it never becomes null. Milk is a system in which the three forms of caseine are in a state of stable equilibrium as regards each other. This state of equilibrium may be disturbed by the addition of minute quantities of different substances, such as mineral salts and diastases. Rennet modifies it in favour of solid caseine and casease in favour of dissolved caseine.

Researches on the Fermentation of Dung.—U. Gayon.—In reference to the memoir of P. P. Dehérain (*Comptes Rendus* of Feb. 11th), the author observes that dung is capable of two quite different fermentations according as it is exposed to the open air or shut up in a closed place. In the former case it is the seat of energetic oxidation which raises the temperature and produces carbonic acid; in the second case it retains its original temperature and evolves a mixture of carbonic acid and of formene. In comparative experiments performed with 250 kilos. of recent horse-dung placed respectively in a well ventilated chest, and in one tightly closed, the temperature rose in the former to 74°, whilst in the latter its maximum was 22°. From the ventilated dung there escaped "torrents of ammonia." As the mass became dry the oxidation ceased and the thermometer fell. If the surface was watered the combustion re-commenced and the temperature rose.

Die Chemische Industrie.
Vol. vii., No. 2, February, 1884.

Two Sodium Calcium Carbonates in the Alkali Manufacture.—Dr. C. Reidemeister.—The author points out that in addition to the crystals of Gay-Lussite (sodium-calcium carbonate) forming in soda-lyes there were also occasionally other crystals which differ from Gay-Lussite crystallographically and chemically, as was determined by Professors Arzruni and Rammelsberg. The formula of Gay-Lussite is $Na_2CO_3+CaCO_3+5aq$. The newly-distinguished form is $2(Na_2CO_3+CaCO_3)+5aq.$, or, in other words, it contains only half as many mols. of water. As regards the conditions under which the one or the other hydrate is formed it is remarked that the compound richer in water (Gay-Lussite) is produced at lower temperatures below 40°, and from a more dilute solution of crude soda. The compound poorer in water is produced at temperatures above 40° and at a higher concentration. A solution which, in the settling troughs may deposit Gay-Lussite on heating or carbonisation may yield the second compound.

Cosmos les Mondes,
No. 5, February 2, and No. 7, February 16.

These numbers contain no chemical matter.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—In addition to the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect T. Brahm. The assistants in the laboratory in the Winter Term 1883-4 were fourteen in number and in the Versuchsstation two. Last Term there were 65 students on the books. Of these, 40 were from Germany, 7 from England, 4 from North-America, 3 from Austro-Hungary, 2 from Switzerland, Luxembourg, and Sweden, 1 from Holland, Belgium, France, Spain, and Russia. The establishment has been enlarged by a special department for practical work in organic chemistry. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

Albumenoids of Milk.—E. Duclaux.—The author points out that caseine is as yet very ill-defined. If we give the name to whatever is precipitated by dilute acids, alcohol, or rennet, we omit to say that in one and the same milk these various reagents precipitate very unequal quantities of matter, and, besides that, one and the same reagent throws down very different proportions according to the temperature, the dilution, the nature, and proportion of the dissolved salts, &c. The author maintains that the albumen of milk, the lactoproteine, as well as the less known bodies, albuminose, galactine, &c., are merely forms of true caseine, insoluble in feebly acid liquids.—*Comptes Rendus*, No. 6.

MEETINGS FOR THE WEEK

Tuesday, 15th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
Wednesday, 16th.—Meteorological, 7.
Thursday, 17th.—Chemical, 8. Ballot. "On the Synthesis of Galena by means of Thio-carbamide," by J. Emerson Reynolds, F.R.S. "Analysis of Woodall Spa," by W. T. Wright and T. Burton.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1273.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 160).

Experiments with Calcic Sulphate.

15. Supposing that the substance giving the citron band formed a sulphate more soluble in water than calcic sulphate, it was anticipated that repeated washings with cold water would extract some of it, which might then be detected more easily. About four pounds' weight of commercial plaster of Paris, which showed very faint traces of the citron band, were mixed with water and rapidly poured on a large filter. Before the mass solidified a slight saucer-like depression was made in the upper part, and a few ounces of water were poured on. This ran through slowly, and it was then poured back and the exhaustion repeated several times. The aqueous extract was then evaporated to dryness, ignited with sulphuric acid, ground in a mortar with small successive quantities of water, the liquid boiled, filtered, and precipitated first with ammonia, and the filtrate with ammonic oxalate. These precipitates both showed the citron band very fairly, far more intensely than it was seen in the original calcic sulphate. The green and red bands were also visible.

The same mass of plaster of Paris was then washed, as before, with a little dilute hydrochloric acid passed through several times, and this extract was treated in the same way by evaporation and extraction with water, and the filtrate precipitated, first with ammonia, and then with ammonic oxalate. In these precipitates the citron band, together with the green and red bands, were much more brightly manifest than in the precipitates from the aqueous extract.

Wide Distribution of the Citron Band-forming Body.

16. These experiments are conclusive in proving that the citron band is not due to calcium, but to some other element, probably one of the earthy metals, occurring in very minute quantities, but widely distributed along with calcium, and I at once commenced experiments to find a more abundant supply of the body sought for. Amongst other substances tested I may note the following as giving a more or less decided citron band in the spectrum when treated with sulphuric acid in the manner indicated above (10):—Crystallised barytic chlorate, heavy spar, common limestone, strontic nitrate, native strontic carbonate, crystallised uranic nitrate, commercial magnesic sulphate, commercial potassic sulphate, Wagnerite (magnesic phosphate and fluoride), zircon, cerite, and commercial ceric oxalate.

Examination of Zircon for the Citron Band.

17. Some specimens of zircon treated in the above manner appeared sufficiently rich to make it probable that here might be found an available source of the citron band-yielding body. I found it in crystals from Green River, North Carolina, from Ceylon, from Expailly, from Miask (Oural), and from Brevig, and having a good supply of North Carolina zircons I started working up these in the following manner:—

The finely-powdered zircons were fused with sodic fluoride, and the melted mass powdered, boiled with sulphuric acid, and filtered. The solution was precipitated with excess of ammonia, the precipitate well washed and dissolved in hydrochloric acid, and the solution made nearly neutral. A little zirconic oxychloride sometimes separated on evaporation; this was filtered off. An excess of sodic thiosulphate was now added, and the whole boiled for some time until a portion of the filtrate gave no further precipitate on boiling again with sodic thiosulphate. The precipitated zirconic thiosulphate was worked up for zirconia; it was found to be quite free from the substance giving the citron band. The solution filtered from the zirconic thiosulphate was precipitated with ammonia, and the brown gelatinous precipitate was well washed. The filtrate was precipitated with ammonic oxalate, which brought down much calcic oxalate. This showed the citron band, but not strongly. The brown gelatinous precipitate was dissolved in nitric acid. Argentic nitrate was added to separate chlorine, and the filtrate from the argentic chloride was boiled down with nitric acid and excess of metallic tin to separate phosphoric acid. The clear solution, separated from the stannic oxide, phosphate, &c., was boiled down with hydrochloric acid to remove nitric acid, and then saturated with hydric sulphide to separate silver and tin.

18. The filtrate from the sulphides was freed from hydric sulphide by boiling, and was then mixed with tartaric acid and excess of ammonia, to precipitate any yttria that might be present, together with Forbes's zirconia β* (jargonia ?). On standing for some hours this gave a small quantity of a precipitate, which was separated by filtration; it was tested in the radiant matter tube, and found not to give the citron-band spectrum (44). To the filtrate ammonic sulphide was added to precipitate the iron. The black precipitate was filtered off, and the filtrate evaporated to dryness, and ignited to destroy the organic matter. The residue, heated with sulphuric acid and ignited, gave the citron spectrum very brightly. This would probably be the earth which Forbes calls zirconia γ.†

19. For many years chemists have suspected that what is known as zirconia might be a compound. Svanberg‡ found that zircons from different localities varied in specific gravity, and the earth or earths obtained by fractional precipitation with oxalic acid had not the same properties, the hydrogen equivalents of the metals of the earths of the different fractions varying from 17·01 to 27·3, the metal of the earth hitherto recognised as zirconia being 22·4.‖ He considered zirconia to contain two different earths, the oxalate of one being less soluble in acid than that of the other, and their sulphates differing in crystalline form and solubility. He proposed the name "noria" for one of the earths, retaining that of zirconia for the other. The researches of Berlin, on the other hand, seem to disprove this.

20. Remembering the remarkable result produced in the absorption spectrum of some jargons by the presence of a minute trace of uranium,§ I tried numerous experiments with this metal, adding small quantities of it to zirconia, lime, thoria, ceria, &c., but in no case could I educe the citron-band spectrum by this means.

I may condense a year's work on zircon—more than ten pounds weight of crystals from North Carolina having been worked up—by stating that the result was comprised in about 300 grains of an earthy residue (18), and about

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

* Chemical News, vol. xix., p. 277.

† *Loc. cit.*

‡ *Poggend. Annal.*, vol. 65, p. 317.

‖ Svanberg's numbers for these earths are 938 to 1320 (M_2O_3), the earth hitherto recognised as zirconia being 1140; oxygen being 100. For the sake of uniformity I have recalculated his equivalents for the metals on the O = 16 scale, taking the formula as M_2O (see note 1, par. 40).

§ Chemical News, vol. xix., pp. 121, 142, 205, 277 vol. xx., pp. 7, 104; vol xxi., p. 73.

two ounces of oxalate, chiefly calcium; the former gave the citron band very well. The process as detailed above is given, since by this means a very large quantity of zircons was worked up, affording me the material which ultimately enabled me to solve the problem which at one time seemed almost hopeless.

The zirconia prepared from these zircons when tested sometimes showed the citron band, especially after precipitation as an oxychloride. Zirconia precipitated as thiosulphate did not yield the citron band (28). A zirconia rich in citron band, fractionally precipitated by ammonia, yielded precipitates of increasing richness, the last fraction showing the citron band strongly.

21. The calcic oxalate obtained from zircon gave unsatisfactory results, so attention was directed to the earthy residue (18). This was found to be of highly complex character, containing thoria (which had escaped precipitation as thiosulphate), ceria, lanthana, didymia, yttria, and probably some of the newly-discovered rarer earths.

Examination of Cerite for the Citron Band.

22. The position of the citron band in the spectrum falls exactly on the strongest absorption band of didymium, so that a piece of didymium glass or cell of solution of the nitrate entirely obliterates the citron band. This naturally suggested that the band was due to didymium.

Cerite was accordingly the next mineral experimented on. The powdered mineral tested in the tube in the original way gave a good citron band. It was made into a paste with sulphuric acid, and after all action had ceased it was extracted with cold water. The earths were then precipitated with ammonic oxalate, and the oxalate ignited. The fawn-coloured powder was then converted into sulphate, dissolved in water, and the cerium metals precipitated by long digestion with excess of potassic sulphate. When no didymium bands could be detected in a considerable thickness of the supernatant liquor it was assumed that all the cerium metals were down, and the liquid was filtered.

23. The precipitated double sulphates were dissolved in hydrochloric acid, and the earths precipitated as oxalates. After ignition and treatment with sulphuric acid, the mixed ceria, lanthana, and didymia were tested in the radiant matter tube, but the merest trace only of citron band was visible.

24. This experiment proved the inadequacy of the didymium explanation (22), and further tests showed that not only could I get no citron band in pure didymium compounds, but the spectrum entirely failed to detect didymium in many solutions of the earth which gave the citron band brilliantly.

25. Attention was now turned to the solution filtered from the insoluble double sulphates from cerite (22). Potash in excess was added to the filtrate, and the flocculent precipitate filtered off, and after well washing was converted into sulphate, and tested in a radiant matter tube. The spectrum, of extraordinary brilliancy, was far brighter than any I had hitherto obtained. Unfortunately, however, the quantity was too small to be subjected to very searching chemical analysis.

Examination of Thorite and Orangite.

26. Search was next made amongst other minerals rich in the rarer earths. Thorite, another disputed mineral, was finely powdered, treated with sulphuric acid, and tested in the radiant matter tube. It gave the citron spectrum most brilliantly—equal, in fact, to the mixture of earths obtained from zircons (18, 21) at so great an expenditure of time and trouble. Orangite treated in the same manner gave almost as good a spectrum. Pure thorinic sulphate prepared by myself was found not to give the citron band, but three specimens prepared and given to me by friends all gave it, so it was not unlikely that in thorite and orangite might at last be found a good source of the long-sought element—that in fact the body I was hunting for, if not thorina, might possibly be Bahr's hypothetical wasium.

Having obtained about 2 lbs. of orangite and thorite, they were worked up as follows:—

27. The finely-powdered mineral was heated for some time with strong hydrochloric acid, and when fully gelatinised and all action had ceased, it was evaporated to dryness to render the silica insoluble; then extracted with water slightly acidulated with hydrochloric acid, boiled, and filtered. Hydric sulphide was passed through the filtrate for some time. The flask then corked was set aside for twenty-four hours and filtered. The filtrate was evaporated to a small bulk, nearly neutralised with ammonia, and then boiled for some time with excess of sodic thiosulphate. This precipitated the thorina, alnmina, zirconia, and titanic acid, whilst it left in solution the metals of the cerium and yttrium groups. The filtrate was boiled down to a small bulk, when a further precipitation took place: this was filtered off and added to the first thiosulphate precipitate. To the clear filtrate excess of ammonic oxalate was added, and the whole allowed to rest twenty-four hours. The precipitated oxalates were filtered, washed, ignited, dissolved in hydrochloric acid, and the excess of acid evaporated off. The aqueous solution was then mixed with a large excess of freshly precipitated baric carbonate, and set aside for twenty-four hours with frequent shaking (29). This would precipitate much of the cerium, and any iron or alumina which might have escaped previous treatment. The liquid was filtered from the precipitate produced by baric carbonate, and the clear solution, which would contain nothing but barium, and some of the yttrium and cerium metals, was treated as described further on (30).

28. The thiosulphate precipitate tested in the radiant matter tube gave no citron band, nor did it seem possible to detect this band on testing the purified thorina obtained from this precipitate, nor from the alumina or zirconia from the same precipitate. This confirmed the results obtained when working up zircons, that sodic thiosulphate did not precipitate the citron band-forming body.

29. The barium precipitate (27) was dissolved in hydrochloric acid, the baryta separated with sulphuric acid, and the solution precipitated with ammonic oxalate. The ignited precipitate, which amounted to 0·223 per cent of the mineral taken, contained the cerium metals. On testing in a radiant matter tube it gave the citron band only moderately well—not nearly so strong as the original thorite and orangite. The iron and alumina in the filtrate from the ceric oxalates were likewise precipitated and tested; they showed a faint trace of citron band.

30. The solution (27) filtered from the barium precipitate was freed from baryta by sulphuric acid, precipitated with ammonic oxalate, and the precipitate washed and ignited; it amounted to only 0·125 of the mineral taken. Tested in the radiant matter tube it showed the citron band about as well as the corresponding earth from the barium precipitate.

This was disheartening, for after having started with a mineral which gave the citron band well, and having hunted the citron band as it were into a corner, the only result was two trifling precipitates showing the citron band less intensely than did the raw material itself. The experiment, however, proved one thing: the band-forming substance was not thorina. The occurrence of this spectrum must therefore be due to some other element present in small quantity in thorite and orangite.

31. The two mixtures of earths—the one from the barium precipitate (29) and the other from the barium filtrate (30)—which showed the citron line moderately well, were dissolved in sulphuric acid, the solution neutralised as nearly as possible with potash, and digested for several days with excess of potassic sulphate. The solution, which at first showed the didymium bands, was then found to be free from didymium.

32. The insoluble double sulphates were filtered and washed with a cold saturated solution of potassic sulphate. The precipitate was boiled for some time in ammonia, filtered, dissolved in hydrochloric acid, and precipitated

with ammonic oxalate. This precipitate was ignited and tested in the radiant matter tube. It gave scarcely a trace of citron band (23). The earth was further purified by the potash and chlorine method, and was found to consist principally of ceric oxide.

33. The solution filtered from the insoluble potassio-ceric sulphate (31) was boiled with ammonia and ammonic sulphide. A small quantity of a white flocculent earth came down—too small a quantity to weigh. Tested in a radiant matter tube, it gave the citron band better than either of the above precipitates, showing that by this treatment the body had been concentrated (25).

34. It seemed possible that the earth sought for might be present in larger quantity in the thorite, but that it had been gradually carried down mechanically or by mass-action rather than chemically, by the numerous operations it had undergone before getting it to the final stage. Therefore a fresh quantity of thorite was extracted with hydrochloric acid. The solution was precipitated with potassic sulphate, taking the usual precautions to secure complete precipitation. A bulky precipitate ensued, which contained the thorina and cerium earths. These were separated and tested, and found to give only a faint citron band.

35. The solution of earthy sulphates soluble in potassic sulphate was precipitated with ammonic oxalate. The precipitate ignited with sulphuric acid, and tested in a radiant matter tube, gave the citron spectrum with great brilliancy (25, 33).

(To be continued.)

ON THE ELECTRO-CHEMICAL EQUIVALENT OF SILVER, AND ON THE ABSOLUTE ELECTROMOTIVE FORCE OF CLARK CELLS.*

By LORD RAYLEIGH, D.C.L., F.R.S.

The investigations upon this subject which have been carried on by Mrs. Sidgwick und myself during the last year and a half, though not yet quite finished, are so far advanced that no doubt remains as to the general character of the results; and as these results have application in the daily work of practical electricians, it is thought desirable to communicate them without further delay.

The currents are measured by balancing the attraction and repulsion of coaxal coils against known weights, as described before the British Association in 1882, a method which has fully answered the favourable expectations then expressed. To what was said on that occasion it will be sufficient for the present to add that the readings were taken by *reversal* of the current in the fixed coils, and the difference of weights thus found (about 1 grm.) represents the double force of attraction, free from errors depending upon the connections of the suspended coil and other sources of disturbance.

The difficulties which have been experienced, and which have been the cause of so much delay, have related entirely to the behaviour of the silver voltameters, of which never less than two, and sometimes as many as five, have been included in the circuit of the measured current. In order to render the deposit more compact, and thus to diminish the danger of loss in the subsequent manipulations, *acetate* of silver was added in the earlier experiments to the standard solution of nitrate. Experience, however, has shown that the principal risk is not in the loss of metal, but in the obstinate retention of salt within the fine pores of the deposit, leading to an over-estimate of the amount. When the texture is very compact this danger increases, and deposits from a solution containing acetate are often decidedly too heavy, even after the most careful and protracted washings. On heating to low redness a portion, at any rate, of the retained salt is decomposed, NO_3 is driven off, and a loss of weight ensues. With pure nitrate, to which we finally recurred, the risk is much less.

The actual weights of deposited silver were usually from 2 to 3 grms., and, so far as the mere weighings are concerned, should have been correct to $\frac{1}{10000}$. Discrepancies three or four times as great as this are, however, actually met with, whether due to retention of salt or to loss of metal it is difficult to say. The final number, expressing in C.G.S. measure the electro-chemical equivalent of silver, is a little lower than that ($1{\cdot}119 \times 10^{-2}$) given on a previous occasion (*Cambridge Proceedings* for November 26, 1883). It approximates closely to $1{\cdot}118 \times 10^{-2}$, and is thus in precise agreement with this number announced within the last few weeks by Kohlrausch, viz., $1{\cdot}1183 \times 10^{-2}$. Its substantial correctness can therefore hardly be doubted, more especially as it does not differ very much from the number (1·124) obtained by Mascart. In terms of practical units, we may say that the ampère current deposits per hour 4·025 grms. of silver.

When we are provided with means for the absolute measurement of currents, the determination of electromotive force is a very simple matter if we assume a knowledge of absolute resistance. A galvanic cell is balanced against the known difference of potentials generated by a known current in traversing a known resistance. The difficulty relates entirely to the preparation and definition of the standard cells. A considerable number of Clark cells have been set up and tested at intervals during the last six months, and their behaviour has been satisfactory, the extreme range (after the first ten days) not much exceeding $\frac{1}{1000}$. A modified form of cell in which the solid zinc is replaced by an amalgam is at present under trial.

In Mr. Latimer Clark's own determination the B.A. unit is assumed to be correct, and the E.M.F. of the cell at 15° C. was found to be 1·457 volt. *On the same assumption*, we obtain the not greatly differing value 1·453 volt. If we take the true value of the B.A. unit as 0·9867 ohm., 1·453 will be replaced by 1·434.

Experiments are also in progress to determine in absolute measure the rotation of the plane of polarisation of light in bisulphide of carbon under the action of magnetic force. Of the results obtained by Gordon and Becquerel, differing by about 9 per cent, our preliminary measurements tend rather to confirm the former.

* A Paper read before the Royal Society, March 27th, 1884.

REMARKS ON THE ATOMIC WEIGHT OF BERYLLIUM.*

By W. N. HARTLEY, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin.

In a reply to a note by Professor Emerson Reynolds "On the Atomic Weight of Glucinum or Beryllium," presented to the Royal Society by Dr. Frankland on June 7th, 1883, Dr. Humpidge has made some critical observations concerning evidence which I adduced in favour of the value 9 or 9·2. I did not consider that these remarks called for notice at the time, as they were beside the question immediately under discussion, namely, the experimental determination of the atomic heat of the metal, but from the fact that they have been abstracted for various journals, and that greater prominence has been given to them than was perhaps originally intended by the author, I beg to be allowed to comment upon them, as my opinions have been entirely misrepresented. Dr. Humpidge states in allusion to me:—"This chemist concludes from his experiments that glucinum is a dyad metal, and that its homologues are calcium, strontium, and barium, elements with which it has not the slightest analogy." From this sentence it

* A Paper read before the Royal Society, April 3rd, 1884.

appears probable that Dr. Humpidge was not fully acquainted with the nature of the evidence advanced, which, however, might be excusable, since, though the two papers in which it was contained were read at the meetings of the Chemical Society, that "On Homologous Spectra" on March 15th, and that "On the Spectrum of Beryllium" on April 19th, they were not published in the Journal in time for him to have consulted them.*

The sentence quoted above is precisely my argument. "The spectrum of beryllium exhibits no marked analogy with the calcium, the magnesium, or the aluminium spectra, all of which are members of well-defined homologous series."

There is nothing similar to the boron, the silicon, or carbon spectrum, nor to those of scandium, yttrium, or cerium. "The spectrum of lithium is the one most allied to that of beryllium in the number, the relative positions, and intensity of the lines." The question, however, whether beryllium is a dyad, and the first member of the series magnesium, zinc, cadmium, is complicated, since it would probably present a spectrum of a different character to the succeeding homologues, in accordance with the following equation, which follows from the periodic law and holds good for the chemical properties of compounds:—

$$Li : Mg = Be : Al = B : Si.$$

"The relation of the spectrum of lithium to that of magnesium is obscure, that of boron to silicon less so; consequently we might expect that the relation of the beryllium spectrum to that of aluminium would not be well defined."

It is further remarked by Dr. Humpidge:—"And it seems strange that Professor Hartley should consider some slight spectroscopic resemblance between glucinum and the metals of the alkaline earths to outbalance all the weighty chemical and physical differences between them."

The nature of the evidence derived from the spectroscope is here quite misrepresented; probably because of its novelty it was not well understood.

I have found that the spectra of magnesium, zinc, and cadmium are the result of three series of harmonic vibrations with similar intervals, the fundamental vibrations of which differ only in pitch. I have made some similar observations with regard to copper, silver, and mercury, aluminium, indium, and thallium, calcium, strontium, and barium, though maps of some of these spectra have not yet been published. I believe that in series of elements such as these, which exhibit gradational differences in properties and in the properties of their compounds, and approximately equal numerical differences in their atomic weights, we are dealing with the same kind of matter in different states of condensation, or, in other words, with matter having similarly constituted molecules, the vibrations of which are in the same direction and at similar intervals but with different velocities.

If we attempt to classify beryllium in accordance with the views of Nilson and Patterson, the elements scandium and yttrium, with atomic weights 44 and 89 respectively, must yield spectra characteristic of the series of which aluminium is the first member, but it is not possible to find a place for beryllium in this group, nor in those to which cerium, lanthanum, and didymium belong; it is, in fact, by a process of exclusion first and selection afterwards that the element falls into the dyad series.

In the position which I assign to beryilium, we can account for it being related, through the properties of its compounds, to magnesium and zinc on the one hand, and to aluminium on the other.

If there is one consideration of greater importance than another which should lead to the determination of the position of an element in a series, it is the mode of vibration of the molecule, and of that we have evidence in the spectrum. When the element is one with a low atomic weight there is no difficnlty in interpreting such evidence.

* The latter paper, which appeared first, was published in the June number of the *Journal of the Chemical Society*, which reached me through the post on June 7th; its date of issue was therefore not earlier than the 5th. The paper "On Homologous Spectra" was delayed until September.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Continued from page 164.)

Situation of the Ferment in the Walls of the Canal.

It has been shown in the case of grape sugar that its converting principle is situated in the deeper parts, and not in the superficial mucous layer of the walls of the alimentary tract. Such is not the case with regard to cane sugar. The superficial surface of the mucous membrane scraped off is quite as efficacious in effecting the transformation of cane sugar as the entire walls. In parallel experiments with cane sugar and grape sugar I have seen that whilst the scrapings of the mucous membrane of the intestine have failed to move grape sugar, cane sugar has been energetically transformed. I have tried the scrapings of the mucous membrane, the parts that were left, and the entire coats against each other, and have not met with results that enable me to formulate any positive difference producible by them.

Action of the Contents of the Stomach upon Cane Sugar.

I have a record of five experiments before me in which cane sugar was kept in contact for twenty and thirty minutes at a temperature of 120° F. with the contents of the stomach of the rabbit taken at a period of digestion. On account of the presence of carbohydrates in the contents themselves, an examination of these placed under parallel circumstances alone required to be made, and the figures deducted from those yielded when cane sugar was employed. An alcoholic extract was made for testing. The results obtained afforded evidence of the occurrence of extensive transformation.

Nature of the Product into which Cane Sugar is Transformed.

The acquirement of a cupric oxide reducing power by a cane sugar product shows that a transformation has taken place, but the question now to be considered is something beyond this—viz., the nature of the body that is produced. For the determination of this point much careful attention has had to be bestowed. I at first thought that the matter stood in a position to be easily disposed of. I had taken the cupric oxide reducing power of the product in a large number of instances before and after treatment with sulphuric acid, and had not observed that the cupric oxide reducing capacity of the product before treatment with sulphuric acid had advanced beyond that of maltose in relation to the reducing power after treatment with sulphuric acid, and was generally less. I therefore thought I was entitled to draw the conclusion that the transformation was into maltose, or into one of the dextrins of less cupric oxide reducing power than maltose, or instead of one of these dextrins that the product consisted of maltose and untransformed cane sugar.

Whilst in this position an instance occurred in which the figures showed that the transformation had advanced to glucose, and subsequently I found that under the influence of a large amount of ferment, or under prolonged action with a less amount, either glucose or something near it in reducing power may be produced. It was in operating with pig's intestine that I first noticed what I have mentioned. The product was exposed to heat one

* A Paper read before the Royal Society, Dec. 20th, 1883.

day and allowed to stand till the following day, when glucose was found to have been produced.

The subjoined may be given as an example illustrative of the production of glucose :—

Experiment.—Scrapings from a considerable length of the cleansed intestine of a rabbit were mixed with water and passed through muslin, so that measured quantities could be taken. Five cub. centims. of a solution of cane sugar, equivalent to 0·096 of glucose, were then mixed respectively with 20 and 40 cub. centims. of the intestinal product, and exposed for two hours to a temperature of 120° F.

Analysis yielded the following results :—

		Cupric oxide reducing power expressed as glucose.
20 c.c. of the intestinal product with 5 c.c. of a solution of cane sugar (=0·096 grm. glucose) exposed for two hours to 120° F.	Before sulph. acid	0·078 grm.
	After „ „	0·092 „
40 c.c. of the intestinal product with 5 c.c. of a solution of cane sugar (=0·096 grm. glucose) exposed for two hours to 120° F.	Before sulph. acid	0·096 grm.
	After „ „	0·096 „

With the employment of the 20 cub. centims. of intestinal product the transformation, it will be noticed, was not carried as far as glucose. The relation in reducing power before and after sulphuric acid in reality stood as 84 to 100. With the 40 cub. centims., on the other hand, the reducing power before was the same as that after glucose therefore existed.

Looking at the fact that cane sugar had been observed to pass into glucose, the important question now presented itself whether with a product presenting the reducing characters of maltose, or a dextrin, such a product really existed, or whether the difference in the reducing power before and after treatment with sulphuric acid was not due to the existence of glucose with untransformed cane sugar. For instance, suppose after the action of the ferment upon cane sugar the product gave a reducing power of 61 before treatment with sulphuric acid and 100 afterwards, this might be due either to the presence of maltose or to 61 of glucose and untransformed cane sugar equivalent in amount to 39 of glucose. Both suppositions are equally applicable by way of argument, and it is only by appeal to observation of a character to afford assistance that the point as to which view is correct can be settled. It is a property of cane sugar to be as readily convertible into glucose by boiling with citric acid as by boiling with sulphuric acid, whilst such I have found is not the case with maltose, whether derived from starch or constituting a product of transformation of cane sugar. A difference here then exists, and I will proceed to show that this difference of behaviour may be turned to account for affording the information required.

In order that the proposition I have advanced may be seen to be well founded I will, as a preliminary step, give the results derived from the examination of actual mixtures of cane sugar and grape sugar, cane sugar and maltose, and grape sugar and maltose.

Mixture of Cane and Grape Sugars.

Ten cub. centims. of a solution of cane sugar containing cane sugar equivalent to 0·213 grm. of glucose were mixed with 10 cub. centims. of a solution of grape sugar containing 0·207 grm. of glucose. Water was added to bring the volume to 150 cub. centims., which was divided into three equal parts. One part was titrated at once; the second boiled with citric acid (in proportion to give a 2 per cent solution), neutralised, and then titrated; and the third was treated in a similar manner with sulphuric acid. From the cupric oxide reducing power of each the figures for the whole volume of 150 cub. centims. were deduced by calculation. Against the figures actually obtained I will place those which theoretically would be yielded.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·207 grm.	0·207 grm.
After boiling five minutes with citric acid	0·420 „	0·414 „
After boiling 1¼ hours with sulphuric acid	0·420 „	0·414 „

Maltose and Cane Sugar.

Ten cub. centims. of the solution of cane sugar containing cane sugar equivalent to 0·213 grm. glucose were mixed with 50 cub. centims. of a solution of maltose, prepared by the action of saliva on starch, and having a reducing power equivalent to 0·165 grm. glucose before boiling with sulphuric acid and 0·426 after. Water was added to bring the volume of the mixture up to 150 cub. centims., and this was then divided into three equal parts, and dealt with in the manner represented below with the results that are given.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·165 grm.	0·165 grm.
After boiling five minutes with citric acid	0·378 „	0·381 „
After boiling 1¼ hours with sulphuric acid	0·639 „	0·651 „

Maltose and Grape Sugar.

Ten cub. centims. of the solution of grape sugar equivalent to 0·201 grm. glucose were mixed with 50 cub. centims. of the solution of maltose, having a reducing power equivalent to 0·165 grm. glucose before boiling with sulphuric acid and 0·426 after, and water added to bring the volume to 150 cub. centims. This was divided into three equal parts, which were dealt with as shown below, the results obtained being mentioned.

	Figures theoretically yielded.	Figures actually obtained.
Before treatment with acid ..	0·372 grm.	0·375 grm.
After boiling five minutes with citric acid	0·375 „	0·375 „
After boiling 1¼ hours with sulphuric acid	0·633 „	0·639 „

(To be continued.)

ON A NEW VOLUMETRIC METHOD FOR THE ESTIMATION OF NITROUS ACID.

By A. G. GREEN and S. RIDEAL, F.C.S.

We have found that the formation of diazo-benzene from aniline by the action of nitrous acid takes place quite quantitatively if sufficient time be allowed, and that on this reaction may be based a very accurate method for the estimation of nitrites. The least excess of nitrous acid remaining after the reaction is complete is indicated on adding starch and potassic iodide. The process is most conveniently conducted as follows :—

A decinormal solution of pure aniline is made up containing rather more than twice its equivalent of acid, one half being hydric sulphate and the other hydric chloride. A weighed quantity of the nitrite to be estimated is dissolved in a known volume of water, so that its strength shall be somewhere between deci- and centinormal. The amount of nitrous acid in this solution is then roughly determined by means of centinormal permanganate or by a

preliminary experiment with the decinormal aniline solution. Several experiments are then made, using the same quantity of the aniline solution in each case, but varying the amount of the nitrite solution within the limits of the rough determination. After standing over-night the reaction will be completed. To each is then added an equal volume of a solution of starch and potassic iodide; the one in which there is a faint blue colour will show that a slight excess of nitrous acid has been added. We find that if the decinormal aniline solution be sufficiently diluted (with about four times its volume of water if the nitrate is about decinormal), and the nitrite run in slowly, the addition of ice is unnecessary.

Our experiments have shown that nitrous acid can be estimated in this way to less than 0·1 per cent, as owing to the extreme delicacy of the starch and potassic iodide test a very small excess of nitrous acid is indicated. The excess of nitrous acid does not seem to suffer much decomposition on standing over-night in the acid solution, but for very accurate results it is best to allow the solutions to stand in an atmosphere of carbonic acid or coal-gas.

Our results were confirmed by using a standard solution of sodic nitrite prepared from a weighed amount of pure silver nitrite.

In addition to its greater delicacy, this method can be used in many cases where, owing to the presence of oxidisable substances, the permanganate process is inapplicable.

Chemical Laboratory,
University College, London.

OPENING UP ZIRCON.

By F. STOLBA.

FINELY ground zircon is quickly rendered soluble if fused with a mixture of potassium borofluoride and potassium carbonate. The author takes two parts of the former to 3 of the latter, and prepares an intimate, finely divided mixture, which is kept ready for use.

Of this mixture 4 parts are taken to 1 of zircon, thoroughly mixed and melted in a platinum crucible at a red heat. The mass fuses readily, froths at first and gives off bubbles of gas, and flows then quietly, forming a very fluid melt. If the zircon is finely ground, 15 minutes are sufficient for this operation. The loss of weight is 15 per cent, and is not notably increased on prolonged fusion. It corresponds approximately to the weight of the carbonic anhydride present in the potassium carbonate.

As pungent vapours are given off during fusion, the operation should be conducted under a draught-hood. The activity of the mixture in attacking zircon appears from the following experiment:—Two zircon crystals, each weighing ½ grm., were introduced into the melted mixture and subjected to prolonged heat. In a short time they decreased perceptibly in size; each of them broke up into two fragments, and within an hour they were entirely dissolved. The melted mass is poured upon a dry metal plate, and when congealed is thrown into water. It is at once intersected with a number of fissures which facilitate pulverisation. This process is the more necessary as the unbroken mass is very slowly attacked by water even on prolonged boiling. The powder is boiled in a large quantity of water so as to remove everything soluble. There is obtained a faintly alkaline solution and a sediment insoluble in water. From the filtrate alkalies throw down zirconium hydroxide, free from iron.

The portion insoluble in water is readily dissolved in hydrofluoric acid and is converted into zircon-potassium fluoride. The chief bulk of the zirconium is found in the aqueous solution in the state of double fluorides. The platinum crucible is not in the least attacked during melting. On the contrary, dirty platinum crucibles may be advantageously cleaned by melting in them a little of the above-mentioned mixture.

If finely divided zircon is boiled for a long time with caustic lye it is perceptibly attacked. It is very probable that in this manner zircon might be entirely dissolved under a pressure of 10 atmospheres.

Potassium borofluoride may be readily prepared from cryolite. Crucibles of nickel seem especially well adapted for the fusion of zircon in caustic alkalies.—*Ber. Bœhm. Gesell. Wissenschaft.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

TELLURIUM.

PARTICULAR interest attaches to the atomic weight of tellurium, on account of the speculations of Mendelejeff. According to the "periodic law" of that chemist, tellurium should lie between antimony and iodine, having an atomic weight greater than 120, and less than 127. Theoretically, Mendelejeff assigns it a value of Te = 125; but all the published determinations lead to a mean number higher than would be admissible under the aforesaid "periodic law." Whether theory or experiment is at fault remains to be discovered.

The first, and for many years the only, determinations of the constant in question, were made by Berzelius.† By means of nitric acid he oxidised tellurium to the dioxide, and from the increase in weight deduced a value for the metal. He published only his final results; from which, if O = 100, Te = 802 121. The three separate experiments give Te = 801·74, 801·786, and 802·838; whence we can calculate the following percentages of metal in the dioxide:—

80·057
80·036
80·034

Mean 80·042 ± 0·005

The next determinations were made by von Hauer,‡ who resorted to the analysis of the well crystallised double salt $TeBr_4.2KBr$. In this compound the bromine was estimated as silver bromide, the values assumed for Ag and Br being respectively 108·1 and 80. Recalculating, with our newer atomic weights for the above named elements, we get from v. Hauer's analyses, for 100 parts of the salt, the quantities of AgBr which are put in the third column:—

2·000 grms.	K_2TeBr_6 gave	69·946	per cent Br.	164·460
6·668	,,	69·8443	,,	164·221
2·934	,,	69·9113	,,	164·379
3·697	,,	70·0163	,,	164·626
1·000	,,	69·901	,,	164·355

Mean 164·408
± 0·045

From Berzelius's series we may calculate Te = 128·045, and from v. Hauer's Te = 127·419. Dumas,‖ by a method for which he gives absolutely no particulars, found Te = 129.

In 1879, with direct reference to Mendelejeff's speculations, the subject of the atomic weight of tellurium was taken up by Wills.§ The methods of both Berzelius and

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 28, 395. 1833.
‡ *Sitzungsb. Wien. Akad.*, 25, 142.
‖ *Ann. d. Chim. et de Phys.*, (3), 55, 129. 1859.
§ *Journ. Chem. Soc.*, Oct., 1879, p. 704.

von Hauer were employed, with various rigid precautions in the way of testing balance and weights, and to ensure purity of material. In the first series of experiments tellurium was oxidised by nitric acid to form TeO_2. The results gave figures ranging from Te = 126·31 to 129·34 :—

2·21613 grms. Te gave	2·77612	TeO_2.	79·828	per cent Te.
1·45313 ,,	1·81542	,,	80·044	,,
2·67093 ,,	3·33838	,,	80·007	,,
4·77828 ,,	5·95748	,,	80·207	,,
2·65029 ,,	3·31331	,,	79·989	,,

Mean 80·015 ± 0·041

In the second series tellurium was oxidised by aqua regia to TeO_2; with results varying from Te = 127·77 to 128·00 :—

2·85011 grms. Te gave	3·56158	TeO_2.	80·024	per cent Te.
3·09673 ,,	3·86897	,,	80·040	,,
5·09365 ,,	6·36612	,,	80·012	,,
3·26604 ,,	4·08064	,,	80·037	,,

Mean 80·028 ± 0·004

Combining these series with that due to Berzelius, we have the following general mean :—

Berzelius	80·042	± 0·005
Wills, 1st series ..	80·015	0·041
,, 2nd ,, ..	80·028	0·004
General mean ..	80·035	0·003

Hence Te = 127·986 ± 0·035.

By von Hauer's process, the analysis of $TeBr_4.2KBr$, Wills's figures give results ranging from Te = 126·07 to 127·61. Reduced to a common standard, 100 parts of the salt yield the quantities of AgBr given in the third column :—

1·70673 grms. K_2TeBr_6 gave	2·80499	AgBr.	164·349
1·75225 ,,	2·88072	,,	164·398
2·06938 ,,	3·40739	,,	164·657
3·29794 ,,	5·43228	,,	164·717
2·46545 ,,	4·05742	,,	164·571

Mean 164·538 ± 0·048

Combined with von Hauer's mean, 164·408 ± 0·045, this gives a general mean of 164·468 ± 0·033. Hence Te = 127·170 ± 0·173.

The two independent values for Te combine thus :—

From TeO_2	Te = 127·986	± 0·035
,, TeK_2Br_6 .. .. ,,	127·170	0·173
General mean .. ,,	127·960	0·034

If O = 16, Te = 128·254.

A careful consideration of the foregoing figures, and of the experimental methods by which they were obtained, will show that they are not absolutely conclusive with regard to the place of tellurium under the periodic law. The atomic weight of iodine, calculated in a previous chapter, is 126·557. Wills's values for Te, rejecting his first series as relatively unimportant, range from 126·07 to 128·00; that is, some of them fall below the atomic weight of iodine, although none descend quite to the 125 assumed by Mendelejeff.

In considering the experimental methods, reference may properly be made to the controversy regarding the atomic weight of antimony. It will be seen that Dexter, estimating the latter constant by the conversion of the metal into Sb_2O_4, obtained a value approximately of Sb = 122. Dumas working with $SbCl_3$ obtained a similar value. Schneider and Cooke, on the other hand, have established an atomic weight for antimony near 120, and Cooke in particular has traced out the constant errors which lurked unsuspected in the work of Dumas and Dexter. Now in some physical respects tellurium and antimony are quite similar. As constant errors vitiated the recently accepted values for Sb, so they may also affect our estimates for Te. The oxidation of Te by nitric acid resembles in minor particulars that of Sb. The analysis of K_2TeBr_6 gives a low value for Te, and yet the material may have contained traces of oxybromides, the presence of which would render even that lower value too high. A careful revision of the atomic weight of tellurium is still necessary.

The following additional note has been communicated by the author :—

According to Brauner (see abstract in *Berichte*, 16, 3055), the atomic weight of tellurium is near 125. His experiments, of which the details are not yet accessible to me, give values ranging from 124·94 to 125·40. Tellurium, then, comes regularly under the periodic law.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, April 7th, 1884.

George Busk, Esq., Treasurer and Vice-President, in the Chair.

Robert Ellis Dudgeon, M.D., David John Russell Duncan, and Willoughby Smith were elected Members of the Royal Institution.

Four candidates for membership were proposed for election.

The arrangements for the Lectures after Easter were announced (see page 179).

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture. Season 1883.

From the Report of the chemist to the Association, Professor Jamieson, it would appear that views hitherto generally accepted concerning the action of manures are undergoing some modification. He ascribes injurious effects to the action of acids generally, but especially sulphuric acid. To quote his own words :—"Sulphur was referred to in a special manner because it had not hitherto been supposed to be injurious, but had actually been supposed to be an essential ingredient in the food of plants, and it was also referred to because those manures sold as soluble manures (dissolved bones and superphosphate) were soaked with it. Many other mixtures sold under the names of 'Corn Manure,' &c., contained more or less of this irritant. Amongst all the plant-irritants the one they had to fear most was sulphuric acid."

To this view the author says he has been "unintentionally and unexpectedly" led by his experiments. How fully this conclusion conflicts with the ordinary opinion may be judged from the following quotations :—In "How Crops Grow," by Johnson, Church, and Dyer, we read, as here quoted (p. 159), "Potash, lime, magnesia, phosphoric pentoxide, and sulphuric trioxide, are absolutely necessary for the life of agricultural plants." Mr. Warington in his "Chemistry of the Farm" (p. 3) writes :—"The incombustible ash always contains five chemical elements—potassium, magnesium, calcium, iron, and phosphorus. These five elements, though forming a very small portion of the plant, are indispensable to its life."

The evidence which Mr. Jamieson offers in support of his opinion is experimental. His operations have been carried on at Hassocks Station, a locality, according to his description, exceedingly suitable. The whole plot enjoys a uniform natural drainage. The whole of the surface soil was removed and the experiments were conducted in the sandy subsoil, which is practically pure and hence barren, being entirely dependent for plant food on the manures supplied. Being, as Mr. Jamieson tells us, "destitute of the varying quantities of corrective black matter contained in ordinary soils it is fitted to show with precision the good or evil effects of ingredients in manures."

One of the author's first objects seems to have been to ascertain whether soluble phosphates have really the decided advantage of insoluble ones—calcium tri- and di-phosphates—that is commonly ascribed to them. He found—and if must be remembered that certain agricultural chemists in Germany are coming to the same conclusion—that the efficacy of insoluble mineral phosphate is only slightly below that of soluble mineral phosphate. Hence the necessity for treating the coprolites, &c., with sulphuric acid to render their phosphates soluble becomes doubtful.

But a further result appeared, viz., that sulphuric acid is in itself a dangerous ingredient, tending to produce in root-crops the well-known evil "club-disease." Thus in the year 1880 and 1881, out of 600 plants treated with dissolved bone-ash alone, or along with other fertilisers, the proportion of diseased roots was from 545 to 594. With undissolved coprolite, and with bone-flour, dung, and coprolite, the numbers of diseased roots out of 600 ranged from 170 to 27! From the same tables we learn another remarkable fact, that if bone-flour was mixed with sulphate of ammonia the proportion of diseased roots out of 600 was, in the two years, 394 and 425. From experiments made in Aberdeenshire the author was led also to conclude that "liberal application of super-phosphate, dissolved bones, sulphate of ammonia, or vitriolised or nitrogenous matters generally, for the turnip crop, would be almost inviting a diseased crop. Upon grain-crops sulphuric acid has a less injurious action. Mr. Jamieson makes the judicious remark that Liebig, when experimentally comparing the relative fertilising power of dissolved and of insoluble phosphates, had not the opportunity of comparing them with precipitated phosphates and with the fine phosphatic flours of the present day.

It will of course be understood that in the sandy soil of Hassocks no substance is present which can mask or modify the properties of sulphuric acid. The author notes, as already shown, that sulphate of ammonia has an injurious action upon root-crops. In discussing the effects of potash on turnips and peas he remarks that "potash salts, whose acids are not required by plants (such as the sulphate and chloride) positively injure or even kill the plants," though soda (set free from nitrate of soda) or a sufficiency of organic matter contained in the soil may prevent this mischief.

Like all previous investigators Mr. Jamieson finds that potash is essential and that its place cannot be supplied by soda.

Concerning the action of nitrogen he comes to the conclusions that urine and guano are hurtful until certain of their ingredients (probably organic acids) are corrected by the soil. Sulphate of ammonia, nitrate of lime, and nitrate of soda give nearly equal results—it would appear with wheat—the difference being always in favour of the nitrate of soda.

The author considers it as practically established that as far as agriculture is concerned neither sulphur, magnesia, nor lime is required in manures; nitrogen, phosphorus, and potash being the only elements required. Nitrogen influences chiefly the grain-crops, phosphorus the root-crops, whilst potassium does not show a marked effect upon one class of plants more than another.

How flatly these results conflict with those of Ville need scarcely be stated. The latter chemist thinks it necessary to add sulphate of lime to manures for every crop, and, apparently, on every kind of soil. How these apparent contradictions are to be reconciled it is not easy to see. Much of the beneficial effect ascribed to lime is due, as is emphasized by Dr. Smith, the State Geologist of Alabama, to its action upon organic matter and mineral compounds present in the soil. As the pure sand of Hassocks contained no such ingredients we may expect that it would be of little avail. We must also weigh the fact that Mr. Jamieson has not experimented upon the fruit-trees of the order *Rosaceæ*, eminently calciphilous.

There is another point which deserves attention. The author infers from his experiments that the "absence of nitrogen is very marked on *all* the crops." Now among these are included not merely grain, grass, and roots, but leguminous crops. Here then we have again a serious discrepancy. Some experimentalists urge that upon plants of this class nitrogenous manures have no influence. They have even been held capable of absorbing and fixing the free nitrogen of the atmosphere. Here, then, is another point on which verbal discussion is useless, and which can be cleared up only by a course of special experiments.

On the subject of soils and their necessary properties Mr. Jamieson makes some very interesting remarks, which point in the direction of reconciling the hitherto conflicting experience and practice of the farmer and of the market-gardener. He distinguishes, as regards soils, two distinct doctrines:—"The common doctrine that the quality of soil depends on the proportion of decaying vegetable matter, a doctrine held by the advocates of vegetable mould, dung, grazing, permanent pasture, and rest; and —what I venture to call the *coming* doctrine—that it depends entirely on the *suitability of the mechanical state of division of the soil particles*."

In rejecting the former doctrine, Mr. Jamieson approximates to the position of M. Ville. He shows that the coarse soil obtained from ground bricks and the ultra-fine soil produced by cement-clay, however rich in mineral plant food, fail to grow crops until their consistency is rendered suitable. If a suitable consistency is obtained good crops are got in the absence of humus, if there is a due supply of moisture and the needful quantity of mineral plant-food. In the experimental plots at Hassocks, humus was wanting, yet on the needful mineral matters being furnished—see Ville on "Artificial Manures," 2nd English edition, pp. 19, 49, 50—good crops were obtained.

But Mr. Jamieson takes a further and not unimportant step. He explains why vegetable mould has come to be regarded by practical men as necessary to fertility. The introduction of organic matter is *one method*, and perhaps the easiest and most obvious of *attaining suitable consistency*. "While organic matter is not essential we must recognise in dung, vegetable mould, and organic matter generally, a valuable adjunct in the cultivation of most soils. This suitability for most soils probably explains the general misapprehension of its real function."

The so-called "loam" of the florists, consisting of the upper layer of an old pasture laid in heaps until the roots of the grasses in it are decayed, is the type of suitable consistency, and in practice it matters little whether such "loam" has been obtained from a sandy, or calcareous, or peaty, or a clay soil.

Mr. Jamieson sums up his conclusions on soils in the following propositions:—"That the proper function of soil is to provide a large quantity of moisture for plants and a very small quantity of mineral matter. That the soil may be called upon occasionally to perform other functions, but that these are subordinate or accidental. That what mainly constitutes good soil is such consistency as will maintain the necessary degree of moisture. This implies freedom from draught and from stagnation also, firmness sufficient for support, but not so great as to present undue resistance to rootlet extension. That certain mineral matters are essential, but the quantities required are comparatively minute. That organic matter is not essential,

though it may often do useful work by assisting to obtain the suitable consistency state and by correcting injurious matter."

Mr. Jamieson is not in favour of permanent pasture—the agriculture of barbarism. He shows that it in reality means "permanent weeds."

Whilst we are not prepared, pending further evidence, to accept the whole of Mr. Jamieson's conclusions, we must admit that his results are exceedingly important and merit careful experimental scrutiny.

Chemical Tables for Elementary Students adapted to the New Syllabus of the Science and Art Department. By W. Joel Kemp, F.C.S. London: Simpkin, Marshall, and Co.

This little work is essentially examinational. To us it is painful to see able, accomplished chemists instead of teaching the science compelled to aim solely at enabling their pupils to pass, and to vary their methods of instruction, not in accordance with their own experience, but to meet the fluctuating demands of a "department." It appears that the new "Syllabus" requires candidates to test two solutions each containing only one of the following metals—silver, lead, mercury, copper, iron, calcium, zinc, magnesium, and potassium, and one only of the following acids—carbonic, nitric, sulphuric, and hydrochloric. Hence the examination of solid substances is excluded. We do not see that the tests recommended or the order of their application varies from those generally adopted in systematic qualitative analysis. Great stress is laid upon nomenclature. The author remarks at the conclusion of his preface:—"As the tendency now is to look upon acids as hydrogen salts, and especially as the Science and Art Department pointedly adopt that view in the Syllabus of the advanced stage, I have ventured to use the terms hydrogen chloride, hydrogen sulphate, &c." We suspect that the risk would have been in adhering to the better known and more convenient terminology.

We cannot censure either the work before us or its author, but we must be permitted to regret the circumstances which render the production of such treatises a matter of necessity.

Experimental Chemistry for Junior Students. By J. Emerson Reynolds, M.D., F.R.S., Vice-president of the Chemical Society, Professor of Chemistry in the University of Dublin. Part III. Metals and Allied Bodies. London: Longmans, Green, and Co.

This is a manual of which we can conscientiously speak with decided approval. The author makes no reference to any kind of examinations and of what may be needed in order to pass them. His declared aim is "to place the student to some extent in the position of an independent investigator of chemical phenomena." This, we need scarcely say, has been the object of all really great teachers of chemistry, such as Liebig and Hofmann, and by no other method can a genuine, living knowledge of the science be imparted.

We note also the following remark:—"The ready-made tables often given for the separation or the metals, though generally good, possess little educational value, and their use often produces unintelligent analysts; whereas the gradual development of such schemes by *the student for himself* is a most useful intellectual exercise."

The passages we have just quoted fully prove that Dr. Reynolds is an opponent of cram, with which, indeed, his method of teaching is simply incompatible. The crammed student, as it has been aptly said, is merely like a Faure's accumulator. He receives what has been passed into him and reproduces it again, with a certain amount of loss. Now Dr. Reynolds evidently seeks to make his students able to reproduce what they have learned, with a certain amount of gain.

The first chapters of this book treat of arsenic, antimony, bismuth, vanadium, tantalum, and niobium, tin, titanium, thorium, and zirconium. In short, simple bodies whose claim to rank as metals is not indisputable, and which, if the division of the elements into metals and non-metals has any scientific value, might form a debateable land on the frontiers.

We are glad to find that the rarer metals are not left out in the cold. Their omission in ordinary manuals may lead the student into serious mistakes both in qualitative and quantitative operation. We notice one passage which may possibly be misunderstood. The author writes:—"Clays suitable for this purpose—*i.e.*, brick-making—should not effervesce much when moistened with hydrochloric acid, indicating the presence of but a small proportion of chalk or lime-stone." This sentence would, we submit, be more intelligible if it ran "Clays suitable for this purpose should effervesce but little when moistened &c."

We find here a notice of the excellent alum clay of Glenarm, in county Antrim, which is now rapidly superseding the French bauxite as a material in the alum-manufacture, owing to its comparative freedom from iron. Whilst the French mineral contains 2·7 per cent of this very undesirable impurity, the Irish bauxite, or alum clay, contains only 0·5. Indeed it will be found that though this treatise is necessarily restricted in bulk there are numerous and accurate references to the industrial applications of the bodies described.

Annual Report of the Board of Regents of the Smithsonian Institution: Showing the Operations, Expenditures, and Condition of the Institution for the Year 1881. Washington: Government Printing Office, 1883.

Turning naturally to the "Report of the Chemist," we find that after examining a part of the collection of minerals then stored in the Smithsonian building, he has been engaged with the inauguration of the new laboratory, which is described in full and shown in plan. The balances are all made by Becker and Son, with the exception of a Jolly's balance for the determination of specific gravities. The assay-room—an important department—where so many ores, &c., have to be examined, is fitted with a Hibb's furnace, with a 4 by 10 inch muffle, a Battersea muffle furnace, with a muffle 6 inches by 14, a crucible furnace and a large sand-bath. There is to be further supplied a small Blake's crusher and a grinding-machine. It is considered that the laboratory is fairly fitted for two chemists, though the supply of platinum ware is considered insufficient. The ventilation is, however, regarded as imperfect; the evaporation-niche too small and its flue not large enough to effect a proper exhaustion.

It is asserted that when the collections of the National Museum have been identified and arranged, it will be found to possess the largest and most complete collection of the minerals, ores, and rocks, not merely of America, but of the world, ever brought together in any one museum.

Among the ores received for assay we find mention of a specimen of arsenical pyrites completely filled with small nuggets of gold, from the size of a pin point to that of an ordinary pin head. They were, indeed, alloyed with a little silver, but the assay showed a value of nearly 30,000 dollars per ton. "Tin ore has been received, though unfortunately the specimens contained no tin; one interesting specimen of this kind presented to the chemist with the assurance that it contained 8 per cent of tin consisted of a mass of small crystals of tourmaline."

The report on the progress of chemistry, by Professor G. F. Barker, of the University of Philadelphia, though an ably-compiled summary, has now merely a historical interest, since it refers merely to the year 1881.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 9, March 3, 1884.

Researches on Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.—This memoir does not admit of useful abstraction.

New Experiments on the Imitation of Electro-chemical Rings by Continuous Currents of Water.—C. Decharme.—The author has made use of a continuous current of water, issuing from a cylindrical or convergent tube (2 to 5 m.m. in diameter), and falling perpendicularly upon a horizontal plate of black glass, moistened over its entire surface. The delivering-tube is fixed at a variable height, but always such that at the distance where the stream encounters the plate it may present no breach of continuity,—an essential condition. It falls then without noise, and produces around the point of impact liquid rings, perfectly fixed. These concentric rings, the diameter and the number of which vary according to the conditions of the experiment, imitate the electro-chemical rings better than the figures produced by the fall of columns of water.

Barium Oxychloride.—G. André.—The author has obtained this compound in a definite state, not mixed either with an excess of base or of chloride. He takes 200 grms. barium chloride, dissolves at a boil in 500 grms. water, withdraws the flask from the fire, and incorporates with the liquid 30 grms. of caustic baryta well pulverised, heats again for five minutes without boiling, and filters. The oxychloride, $BaCl,BaO_5HO$, crystallises in a few hours in nacreous laminæ.

New Group of Nitrogenous Compounds.—R. Engel.—The author has obtained a third isomer of lactamide. It is not crystalline: if heated to 200° it does not distil like lactamide, but is decomposed. In presence of water it yields immediately ammonium lactate. Thus its ammonia may be entirely precipitated in the cold by platinum chloride, which is not the case with normal lactamide.

The Oxidation of Menthol by means of Potassium Permanganate.—G. Arth.—The author has obtained by this reaction two distinct acids. The second of these seems to be an intermediate product between the former, $C_{10}H_{18}O_3$, and the carbonic and oxalic acids.

Two Camphol-urethanes of an Isomerism analogous to those presented by Dextro and Lævo-Tartaric Acids.—M. Haller.—The crystals yielded by dextro-camphol are hemihedral to the right, and their solution deflects the plane of polarisation to the right. The crystals derived from lævo-camphol are hemihedral to the left, and deflect the plane of polarisation to the left. This dyssymmetry is in all points similar to that presented by the dextro and lævo double ammonium-sodium tartrates.

Die Chemische Industrie.
Vol. vii., No. 2, February, 1884.

Phosphoric Acid, soluble in the Soil.—Dr. A. Stutzer.—The author points out that the use of ammonium citrate was originally proposed by Prof. Fresenius for distinguishing "reverted" phosphoric acid from that portion of phosphoric acid in phosphatic minerals which has never been rendered soluble in water. He complains that this method designed for one special case has been used for phosphoric acid which *is rendered soluble in the soil.* Under this latter term he understands all forms of phosphoric acid combined with lime, iron, alumina, &c., which in consequence of their physical or chemical nature are capable of serving as plant-food. For the determination of such phosphoric acid ammonium citrate is ill-adapted, as it dissolves only very insignificant quantities. As a substitute he proposes a dilute solution of free citric acid. His method is as follows:—5 grms. of the manure passed through a 1-millimetre sieve are placed in a litre flask and let stand in the cold for an hour with ½ litre of a 1 per cent solution of citric acid, with occasional shaking. Moist manures are of course ground up in the mortar. The flask is then filled up to the mark with water and the proportion of phosphoric acid is determined by the molybdenum method in a portion of 50 or 100 c.c. It is not necessary to destroy the citric acid. In precipitated phosphate prepared from iron slags the silica must be previously removed by evaporating 200 c.c. of the citric solution to dryness with the addition of potassium chlorate and hydrochloric acid, heating to 110°, taking up the residue with a little nitric acid, diluting to 200 c.c., and then determining the phosphoric acid in 50 c.c. The author considers that a thorough examination of the capabilities of this method is the more important as it is now very generally admitted that phosphoric acid soluble in water, and such as dissolves only in the soil, are approximately equal in value.

Cosmos les Mondes,
No. 8, February 23, 1884.

Storms and Telegraphs.—In France, telegraphic communication was seriously compromised for 48 hours by the tempest of January 26th. But for the subterranean wires to Lille, Nancy, and the principal towns of the north and east, Paris would have been entirely cut off from the provinces.

The Skrivanow Pocket Battery.—The element is constructed of sheet zinc and silver chloride wrapped in parchment paper, immersed in a solution of 75 parts of caustic potassa in 100 of water. The whole is placed in a small trough of gutta-percha which can be closed hermetically. The conductors and external contacts are of silver. Such an element, when complete, weighs about 100 grms.. Its electromotive force is 1·45 to 1·50 volt, and it yields for an hour a current of 1 ampère.

No. 9, March 1.

Combination-Heat of Soluble Fluorides and the Law of Thermic Substitution Constants.—D. Tommasi.—M. Guntz has quite recently determined the combining-heats of certain fluorides, and the values which he has obtained are identical with those predicted in accordance with his law. As for the combination-heats of barium, strontium, and calcium fluorides, their insolubility prevents the application of the law.

Law of Thermic Constants.—D. Tommasi.—The author gives a table of twenty compounds of magnesium, zinc, copper, and lead, in which the combination-heats, as determined and as predicted according to the above law, are found to agree very closely. M. Tommasi complains of the suppression of this table in his communication sent to the Academy of Sciences.

No. 10, March 8.

This issue does not contain any chemical papers.

Moniteur Scientifique, Quesneville.
March, 1884.

Société Industrielle de Mulhouse: January 9, 1884.—M. Matthieu Plessy sent in a memoir on a tribasic aluminium oxalate. This compound is formed as a white crystalline paste on heating to 150° in a closed vessel tribasic aluminium sulphate in a paste with an excess of a solution of neutral aluminium oxalate. It is also obtained on attacking metallic aluminium with a solution of oxalic acid at 150°.

M. Noelting communicated the continuation of his researches on the xylidines, undertaken in concert with M. Forel. By oxidising symmetrical metaxylidine they obtained metaxylo-quinone, melting at 73°, and by its reduction a metaxylo-hydroquinone fusible at 149°.

M. Casthelaz called the attention of the Committee to a double potassium-antimony oxalate sold as tartar emetic, and containing 23·67 per cent antimony oxide instead of 43·70 per cent.

Solid and Liquid Illuminating Agents.—L. Field.—From the *Journal of the Society of Arts*.

Thickeners, Resists, and Discharges on Printed Calico, as used principally in England.—Robert Bourcart, of Manchester.—Apparently from an English source.

Researches on the Ptomaines and Analogous Compounds.—Dr. Pouchet.—The author obtained certain liquid products, strongly odorous, sparingly soluble in water, very soluble in alcohol, and partially soluble in ether, and consisting of volatile bases mixed with variable substances; and also certain solid products, the quantity of which is very variable, and from which he has obtained two well-defined chloro-platinates. All these compounds are violent poisons, and kill frogs rapidly, occasioning torpor and paralysis, with abolition of reflex movements. The heart stops in systole. Some of the coloured reactions which they produce are absolutely identical with those considered as characteristic of certain vegetable alkaloids, especially aconitine.

Memoir on Printing with Natural Indigo, presented to the Industrial Society of Mulhouse.—Robert Bourcart.—This memoir has appeared in full, with illustrations and specimens, in the *Journal of the Society of Chemical Industry*.

Review of Researches Published Abroad.—G. de Bechi.—A series of abstracts from the *Berichte Deutsch. Chem. Gesell.*, *Liebig's Annalen*, and the *Journ. fur Prakt. Chemie*.

Review of Recent Researches on the Distillation of Coal.—H. Gall.—The papers here inserted are all of English origin.

MISCELLANEOUS.

Notice to Impostors.—We have received numerous letters from scientific men saying that a plausible foreigner, representing himself to be related to some well-known chemist, has succeeded in getting money from them by a more or less distressing tale, which has turned out to be false. We ourselves were similarly victimised a short time ago. It would occupy too much space to print all these communications, so we give this general notice in the hope that the gentleman in question, being satisfied with the good haul he has got out of tender-hearted men of science, will in future devote his persuasive talents to harder-hearted men of the world, who are so much more able to indulge in the luxury of giving.

Royal Institution.—The following are the arrangements for the Lectures after Easter:—

Dr. Klein—Two Lectures on the "Anatomy of Nerve and Muscle," on Tuesdays, April 22 and 29.

Prof. Gamgee—Five Lectures on the "Physiology of Nerve and Muscle," on Tuesdays, May 6 to June 3.

Prof. Dewar—Seven Lectures on "Flame and Oxidation," on Thursdays, April 24 to June 5.

Mr. Hodder M. Westropp—Three Lectures on "Recent Discoveries in Roman Archæology," on Saturdays, April 26 to May 10.

Prof. T. G. Bonney—Four Lectures on the "Bearing of Microscopical Research upon some large Geological Problems," on Saturdays, May 17 to June 7.

The following are the probable arrangements for the Friday Evening Meetings after Easter, 1884, to which Members and their friends only are admitted:—

April 25.—Walter Besant, Esq., "The Art of Fiction."

May 2.—Professor J. W. Judd, F.R.S., Sec. G.S. "Krakatoa."

May 9.—Professor W. Robertson Smith, M.A., LL.D. "Mohammedan Mahdis."

May 16.—Professor W. Odling, M.A., F.R.S., M.R.I. "The Dissolved Oxygen of Water."

May 23.—David Gill, Esq., LL.D., F.R.S., Her Majesty's Astronomer at the Cape, "Recent Researches on the Distances of the Fixed Stars, and some Future Problems in Sidereal Astronomy.

May 30.—Monsieur E. Mascart, Professeur au Collège de France. "Sur les Couleurs" (in French).

June 6.—Professor Dewar, M.A., F.R.S., M.R.I.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chromium in Iron.—Would any of your subscribers inform me of any method of getting rid of chromium in pig-iron?—CHROMIUM.

Arsenical Mundic.—Can any correspondent tell me the value of arsenical mundic (mispickel) containing 80 per cent of metallic arsenic delivered in Swansea? I have at my disposal a vein of this substance about a mile long and several yards thick, on a mountain side.—LUX.

TO CORRESPONDENTS.

J. Mighall.—A little carbolic acid will prevent the solution decomposing. One per cent will be sufficient.

MEETINGS FOR THE WEEK

MONDAY, April 21st.—Medical, 8.30.
—— Society of Arts, 8. Adjourned Discussion on Dr. Frankland's Paper on "The Upper Thames as a Source of Water Supply."
TUESDAY, 22nd.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Dr. Klein.
WEDNESDAY, 23rd.—Society of Arts, 8. "Thames Communcations," by J. B. Redman, M.Inst.C.E.
—— Geological, 8.
THURSDAY, 24th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
FRIDAY, 25th.—Royal Institution, 8. "Art of Fiction," by Mr. W. Besant, at 9.
—— Society of Arts, 8. "The Existing Law of Landlord and Tenant in India," by W. G. Pedder.
—— Quekett Microscopical Club, 8.
SATURDAY, 26th.—Royal Institution, 3. "Roman Archæology: the Colosseum," by Mr. H. M. Westropp.
—— Physical Society, 3. "On an Indicator Diagram of a Gas Engine," by Profs. W. E. Ayrton and J. Perry. "On a New Speed Indicator," by W. T. Goolden. "On a Speed Indicator," by W. Baily. "On a Metrical Barometer, and on an Immersion Galvanometer," by Dr. W. H. Stone, F.R.C.S.

ST. PAUL'S SCHOOL.—An EXAMINATION for filling up about six VACANCIES on the Foundation will be held on the 29th April.—For information, apply to the Clerk to the Governors, Mercers' Hall, E.C.; or to the School Secretary, St. Paul's Churchyard, E.C.

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The Commissioners do not bind themselves to accept the highest or any Tender.

J. D. MARWICK, Town Clerk, Clerk to the Commissioners.

City Chambers, Glasgow, 11th March, 1884.

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The Gas Committee of the Corporation of Manchester are prepared to receive TENDERS for the Purchase and Removal of the Ammoniacal Liquor to be produced at the Gayshorn, Rochdale Road, and Bradford Road Gas Works during a period of one or more years, commencing at noon on the 24th day of June, 1885.

The Committee do not bind themselves to accept the highest or any tender. Sealed tenders, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Ammoniacal Liquor," must be delivered at the Offices of the Gas Department, Town Hall, on or before Monday, the 12th day of May proximo.

Forms of Tender and further particulars may be obtained on application in writing to Mr. CHARLES NICKSON, Superintendent of the Department.

A deposit of one guinea (which will be returned on receipt of the tender) must accompany each application for a Tender Form.

By order of the Gas Committee.

JOS. HERON, Town Clerk, Manchester.

Town Hall, 7th April, 1884.

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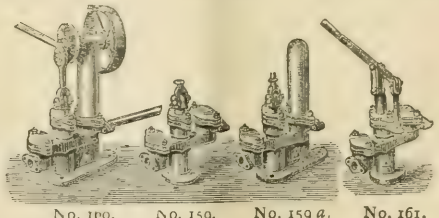

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1274.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 171).

Chemical Facts connected with the Citron Body.

36. Certain chemical facts concerning the behaviour of the sought-for element which came out during the course of the tentative trials already described had considerably narrowed the list amongst which it might probably be found. All the evidence tended to show that it belongs to the group of earthy metals, consisting of aluminium, beryllium, thorium, zirconium, cerium, lanthanum, didymium, and the yttrium family, together with titanium, tantalum, and niobium. The sought-for earth is insoluble in excess of potash (25); this excludes aluminium and beryllium. It is not precipitated by continued boiling with sodic thiosulphate (17, 27); this excludes aluminium, thorium, and zirconium. Fused with acid potassic sulphate, the resulting compound is readily soluble in cold water; this excludes tantalum and niobium. Evaporating to dryness with hydrochloric acid and heating for some time does not render the mass insoluble in water (27); this excludes titanium and silicium. It is easily soluble in an excess of a saturated solution of potassic sulphate (25, 33, 34); this excludes thorium, the cerium group, some of the numerous members of the yttrium group, and zirconium. The only remaining elements among which this elusive body would probably be found are those members of the yttrium family which are not precipitated by potassic sulphate.

37. On the other hand, the body giving the citron band spectrum did not behave like one of the known earths. A rich residue was fused with sodic carbonate, and the mass extracted with water. The insoluble residue, on testing in the usual way, was rich in citron band, but subsequent treatment of the aqueous solution gave me an earth which also gave the citron band strongly.

An acid solution of the citron body was precipitated by ammonia and ammonic chloride. The earth was not completely precipitated, but after a long boiling some remained in solution. I have since ascertained that the detection of the citron-band body in solution under these circumstances is only owing to the marvellous delicacy of the test, which carries our powers of recognition far beyond the resources of ordinary chemistry.

38. Besides obtaining indirect evidence that the citron band was not due to certain elements, I tried special experiments with each substance, brought to the highest possible state of purity. In many cases I detected more or less traces of citron band; but I had come to the conclusion, abundantly warranted by facts, that this citron band was an extraordinarily sensitive test of the presence of the element causing it; and the minute chemistry of many of these earthy metals being insufficiently known, it was not surprising that traces of one of them should adhere to another in spite of repeated attempts to purify it out. With each successive fractional precipitation the citron band became fainter, showing that with perseverance the last trace would probably disappear. The time this process would have occupied, in my opinion, seemed not worth the little additional evidence it would have afforded.

39. Taking into consideration the extremely small quantity of phosphorescent material which had so far been obtained, all these experiments justified me in assuming that the body sought for not only belonged to the group of earths, but also most probably to the sub-group not precipitated by potassic sulphate to which yttria belongs. As, however, the number of these metals has increased so much within the last few years, and as the quantity of material which I had up to the present at my disposal was too small to admit of a satisfactory chemical examination being made of it, search was commenced among other sources known to be rich in these metals. Besides, not only did the majority of the substances I had up till now obtained in anything like quantity indicate the citron band earth to belong to the yttria group (33, 34, 36), but also that either the earth itself showed an absorption band in the spectroscope, or was invariably accompanied by one which did. On the other hand, I had a certain amount of evidence that the earth sought for did not show a band in the spectroscope (24); but remembering the extremely small quantity of very impure substance experimented with, the evidence on this point was not at all conclusive.

The Sought-for body one of the Yttrium Family.

40. The yttria earths form a somewhat numerous family. Fortunately for chemists, a mineral rich in yttria earths —samarskite—has been found in large quantity in Mitchell County, North Carolina, and to this mineral I accordingly now directed my attention.

The annexed list of elements of the yttrium and its allied families, said to occur in samarskite and similar minerals, may be considered complete to the present time. (See next page.)

41. Some of these claimants will certainly not stand the test of further scrutiny. Thus samarium and yttrium β are in all probability identical; and I should scarcely have included philippium, as Roscoe* has conclusively proved that this is a mixture of terbium and yttrium, and my own results (61) confirm those of Roscoe. Moreover, others of these so-called elements will probably turn out to be mixtures of known elements. But in the confessedly very imperfect state of our knowledge of the chemistry of these metals it is not safe for me in this research to assume that any one of them will surely not survive. The complete list as it stands will therefore be taken to contain all hitherto claimed as new, although it is almost certain to include too many.

The Sought-for Body has no Absorption Spectrum.

42. In the second column "Yes" or "No" indicates whether the solutions give an absorption spectrum when examined by transmitted light. Now could I definitely settle whether solutions of the citron-band body gave an absorption spectrum or not, I could at once eliminate a whole class of elements.

This was not difficult to determine. I have already said (22, 24) that spectroscopic examination entirely failed to detect didymium in many solutions of the earth which gave the citron band strongly. This was not always the case. In early days of this research I frequently obtained absorption bands innumerable when the citron-band body was known to be present; but as I became better acquainted with the chemical reactions of the new earth I gradually succeeded in eliminating one after the other those metals yielding absorption spectra. The earth from zircons (18, 21) gave the most satisfactory results in this respect. This, after removing the little didymium present, gave but a trace of an absorption spectrum, which from its general appearance was probably due to erbia. The earth obtained from cerite (25), which gave the citron spectrum with great brilliancy, on the other hand yielded no absorption spectrum; and generally I may say that

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

* *Journ. Chem. Soc.*, vol 41, p. 277.

Name.	Absorption Spectrum.	Hydrogen equivalent of Metal.(1) (Type of Oxide M_2O.)
Cerium	No	47·1 (2)
Columbium (3)	Yes	—
Decipium	Yes	57·0 (4)
Didymium	Yes	48·5 (5)
Didymium β	Yes	47·0 (6)
Erbium	Yes	53·3 (7)
Holmium (8)	Yes	54·0 (9)
Lanthanum	No	46·0 (10)
Mosandrum	No	51·2 (11)
Philippium (12)	No	—
Rogerium (13)	Yes	—
Samarium	Yes	50·0 (14)
Scandium	No	14·7 (15)
Terbium	No	49·5 (16)
Thorium	No	58·4
Thulium	Yes	56·5 (17)
Ytterbium	No	57·9 (18)
Yttrium	No	29·7 (19)
Yttrium α	No	52·2(20)
Yttrium β	Yes	49·7 (21)
Zirconium	No	22·5

(1) As it is at present doubtful whether the oxides of several of the metals in this table belong to the type M_2O. M_2O_3, or MO, I have, for the sake of uniformity and simplicity, in calculating the values from the composition of their salts, by which these metals are chiefly discriminated, taken the type of oxide to be M_2O.

(2) BÜHRIG, "J. Pr. Chem.," ser. 2, vol. xii., p 209.

(3) Dr. J. LAWRENCE SMITH in a paper read before the United States National Academy of Sciences in 1879, announced the discovery in Samarskite of two new elements, which he named Columbium and Rogerium ("Nature," vol. xxi., p. 146). I have failed to find any further notice of these elements. This Columbium must not be confounded with the well-known Columbium, sometimes called Tantalum.

(4) DELAFONTAINE, "Comptes Rendus," vol. lxxxvii., p. 632, vol. xciii., p. 63; "Chemical News," vol. xxxviii , p. 223, vol. xliv., p. 67.

(5) CLÈVE, "Bull. Soc. Chim.," ser. 2, vol. xxi., p. 246; BRAUNER, "Comptes Rendus," vol. xciv., p. 1718; "Chemical News," vol. xlvii., p. 175.

(6) CLÈVE, "Comptes Rendus," vol. xciv., p. 1528; "Chemical News," vol. xlv., p. 273. BRAUNER, "Comptes Rendus," xciv., p. 1718; "Chemical News," vol. xlvi., p. 16.

(7) CLÈVE, "Comptes Rendus," vol. xci., p. 381; "Chemical News," vol. xlii., p. 199; LECOQ DE BOISBAUDRAN, "Comptes Rendus," vol. lxxxix., p. 516; "Chemical News," vol. xl., p. 147.

(8) Called by SORET, the first discoverer, "X." Subsequently CLÈVE discovered the same metal and called it holmium. SORET has now adopted CLÈVE'S name. "Comptes Rendus," vol lxxxix., p. 708, and vol. xci., p. 378; "Chemical News," vol. xl., p. 224, and vol. xlii., p. 199. LECOQ DE BOISBAUDRAN, "Comptes Rendus," vol. lxxxix., p. 516; "Chemical News," vol. xl., p. 147.

(9) CLÈVE, "Comptes Rendus," vol. lxxxix., p. 478; "Chemical News," vol. xl., p. 125.

(10) BRAUNER, "Comptes Rendus," vol. xciv , p. 1718; "Chemical News," vol. xlvi., p. 16.

(11) LAWRENCE SMITH, "Comptes Rendus," vol. lxxxvii., pp. 145, 146, 148. MARIGNAC, *ibid.*, vol. lxxxvii., p. 281. DELAFONTAINE, in October, 1878 (*ibid.*, vol. lxxxvii., p. 600), considers mosandrum a mixture of terbium, yttrium, erbium, didymium, and philippium. Subsequently, however, LAWRENCE SMITH, in November, 1878 (*ibid.*, vol. lxxxvii., p. 831), adduces chemical and other reasons to show that his mosandrum is not a mixture, but a true element. A year later, September 1, 1879 (*ibid.*, vol. lxxxix., p. 480), LAWRENCE SMITH repeats the claim for mosandrum to be classed with the elements.

(12) DELAFONTAINE, "Comptes Rendus," vol. lxxxvii., p. 559; "Chemical News," vol. xxxviii., p. 202; "Journ. Chem. Soc.," vol. xxxvi., p. 116.

(13) *See* Note (3) to columbium, *ante*.

(14) LECOQ DE BOISBAUDRAN, "Comptes Rendus," vol. lxxxviii., p. 322, and vol. lxxxix., p. 212; "Chemical News," vol. xxxix., p. 115, and vol. xl., p. 99. BRAUNER, "Chemical News," vol. xlvii., p. 175: CLÈVE, "Comptes Rendus," vol. xcvii., p 94; "Chemical News," vol. xlviii., p. 39.

(15) NILSON, "Comptes Rendus," vol. xci., p. 118; "Chemical News," vol. xlii., p. 83. CLÈVE, "Comptes Rendus," vol. lxxxix., p. 419; "Chemical News," vol. xl., p. 159.

(16) MARIGNAC, "Ann. Chim. et Phys.," ser. 5, vol. xiv., p. 247; "Journ. Chem. Soc.," vol. xxxvi., p. 113. DELAFONTAINE, "Ann. Chim. et Phys.," ser. v., vol. xiv., p. 238; "Journ. Chem. Soc.," vol. xxxvi., p. 114.

(17) CLÈVE, "Comptes Rendus," vol. lxxxix., p. 478, and vol. xci., p. 328; "Chemical News," vol. xl., p. 125, and vol. xlii., p. 182. THALEN, "Comptes Rendus," vol. xci., p. 376: "Chemical News," vol. xlii., p. 197.

(18) MARIGNAC, "Comptes Rendus," vol. lxxxvii., p. 578; "Chemical News," vol. xxxviii., p. 213. NILSON, "Comptes Rendus," vol. lxxxviii., p. 642, vol. xci., p. 56; "Chemical News," vol. xlii., p. 61.

whenever I started with a sufficient quantity of an earth giving both citron-band spectrum and absorption spectrum, I could, by appropriate chemical means, always separate it into three portions,—one which gave the citron-band spectrum with great brilliancy, and showed in concentrated solution a very faint absorption spectrum, and frequently none at all; another which gave very little citron-band spectrum, but a good absorption spectrum; and a third intermediate portion—about four-fifths of the whole—which gave both citron-band and absorption spectrum. This portion, by repetition of the treatment, could again be split up in the same way, and the operation repeated as often as the stock of material held out.

43. Having definitely settled the question that the metal giving the citron-band spectrum was not one of those giving an absorption spectrum, the possible elements become materially narrowed to the following list:—Cerium, lanthanum, mosandrum, scandium, terbium, thorium, ytterbium, yttrium, yttrium α, and zirconium.

Of these the potassic sulphate reaction (36) excludes cerium, lanthanum, scandium, thorium, yttrium α, and zirconium, so there are left only the following:—

Mosandrum,
Terbium,
Ytterbium,
Yttrium.

44. Certain chemical reactions for a long time made me dismiss yttrium from the list of likely bodies. In my analysis of zircons (18), towards the latter part of the process, I used the following process to separate the iron:—The solution, mixed with tartaric acid and excess of ammonia, was allowed to stand for some time. A small quantity of a precipitate gradually formed, which was filtered off, and it was this filtrate, after separating the iron with ammonic sulphide, that yielded the greatest quantity of substance giving the citron band. Now one of the methods of separating yttria from alumina, berylla, thoria, and zirconia is to precipitate it as tartrate in the presence of excess of ammonia, the other earths remaining in solution. Fresenius says:—"The precipitation ensues only after some time, but it is complete."

The precipitate thus obtained with tartaric acid and ammonia should therefore contain all the yttria: *it gave no citron band whatever in the radiant matter tube;* whilst the residue, which should be free from yttria (18), proved for a long time the only source of material wherewith to investigate the chemical properties of the body giving the citron spectrum.

45. Another reason which made me, at this stage of the research, pass over yttria, was that I had already tested this earth in the radiant matter tube. In a paper on 'Discontinuous Phosphorescent Spectra in High Vacua," read before the Royal Society, May 19th, 1881,* I said—"Yttria shows a dull greenish light giving a continuous spectrum" (75).

For these reasons I for a long time omitted yttria from my list of possible bodies, and considered that the earth, if not a new one, might turn out to be either mosandra, terbia, or ytterbia.

(To be continued.)

Absorption Spectrum of Water.—J. L. Soret and E. Sarasin.—The authors detect in the orange a very slight and narrow dark band, a little less refrangible than the ray D, about at the fifth part of the interval comprised between D and C, but nearer D, corresponding approximately to the wave-length 600.—*Comptes Rendus.*

(19) CLÈVE, "Comptes Rendus," vol. xcv., p. 1225; "Chemical News," vol. xlvii., p. 4; "Bull. Soc. Chim.," vol. xxxix., p. 120; "Chemical News," vol. xlvii., p. 143.

(20) MARIGNAC, "Comptes Rendus," vol. xc., p. 899; "Chemical News," vol. xli., p. 250.

(21) This is almost certainly identical with LECOQ DE BOISBAUDRAN'S samarium. See MARIGNAC, "Comptes Rendus," vol. xc., p. 899; "Chemical News," vol. xli., p. 250. SORET, "Comptes Rendus," vol. xci., p. 378; "Chemical News," vol. xlii., p. 199.

* *Proc. Roy. Soc.*, No. 213, 1881.

ON THE

PHYSIOLOGY OF THE CARBOHYDRATES IN THE ANIMAL SYSTEM.*

By F. W. PAVY, M.D., F.R.S.

(Concluded from page 173.)

THUS observation shows that there is no difficulty in distinguishing the carbohydrates in combinations under the conditions required to be unravelled, and now let us see how the results stand when the mode of investigation described is put into practice.

Experiment.—Some cane sugar, scrapings from the intestine of a dog, and about 150 c.c. of water were placed in a wide mouthed bottle and exposed to a temperature of 120° F. 20 c.c. were removed at the subjoined periods, made up to 150 c.c. with water, divided into three parts of 50 c.c. each, and examined—one part by titration at once, and the other two parts after boiling for seven minutes with citric acid (2 per cent strength) and sulphuric acid respectively. The figures give the cupric-oxide reducing power expressed as glucose, calculated for what it would be under the different circumstances in the whole 150 c.c. (to which the 20 c.c. were diluted) of liquid each time subjected to analysis. An analysis of the intestinal product itself that was employed gave no reducing action before or after treatment with sulphuric acid.

At the end of five minutes.

	Cupric oxide reducing power expressed as glucose.
Before treatment with acid	0·036 grm.
After boiling with citric acid	0·087 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of ten minutes.

Before treatment with acid	0·042 ,,
After boiling with citric acid	0·096 ,,
After boiling with sulphuric acid ..	0·123 ,,

At the end of fifteen minutes.

Before treatment with acid	0·045 ,,
After boiling with citric acid	0·093 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of twenty minutes.

Before treatment with acid	0·060 ,,
After boiling with citric acid	0·093 ,,
After boiling with sulphuric acid ..	0·123 ,,

At the end of thirty minutes.

Before treatment with acid	0·063 ,,
After boiling with nitric acid	0·093 ,,
After boiling with sulphuric acid ..	0·120 ,,

At the end of forty-five minutes.

Before treatment with acid	0·066 ,,
After boiling with citric acid	0·087 ,,
After boiling with sulphuric acid ..	0·123 ,,

Let us now examine these figures. At the end of five minutes the 20 c.c. of liquid taken from the bottle contained a product derived from the transformation of the cane sugar originally present, possessing a cupric oxide reducing power equivalent to 0·036 grm. of glucose. After boiling with citric acid the contents of the 20 c.c. possessed a reducing power equivalent to 0·087 grm. glucose, and after boiling with sulphuric acid 0·120 grm. of glucose. The last figures actually represent glucose, and give the total amount producible from the carbohydrate present in the 20 c.c. of liquid. Now, if the 20 c.c. of liquid removed at the end of five minutes had contained glucose and untransformed cane sugar, as cane sugar is convertible into glucose by boiling with citric acid, the figures would have been raised after boiling with citric acid from 0·036 to 0·120, or to the same as after boiling with sulphuric acid. As a matter of fact they were only raised to 0·087. It is, therefore, absolutely manifest that the carbohydrate corresponding with the difference between 0·036 and 0·120 could not simply represent untransformed cane sugar. But the difference between 0·036 and 0·087 may be read as constituting untransformed cane sugar converted into glucose by boiling with citric acid, and if we deduct this representative of untransformed cane sugar which amounts to 0·061 from the total carbohydrate expressed as glucose, viz., 120, the result will be that a product is left with a reducing power equivalent to 0·036 grm. of glucose before treatment with sulphuric acid and 0·069 after, that is, a dextrin possessing a cupric oxide reducing power standing in the relation of 52 to glucose at 100.

With the other portions that were removed at successive periods the figures show a progressive conversion of the cane sugar originally present. At the end of 45 minutes the 20 c.c. possessed a reducing power before treatment with acid equivalent to 0·066 grm. of glucose, 0·087 after treatment with citric acid, and 0·123 after treatment with sulphuric acid. The difference between 0·066 and 0·087 represents untransformed cane sugar which had become reduced to that which corresponds with 0·020 grm. glucose instead of 0·051 grm., as in the first 20 c.c. removed for analysis. Taking away the untransformed cane sugar, a product is left with a reducing power equivalent to 0·066 grm. of glucose before treatment with sulphuric acid and 0·102 after. These figures stand in the relation of 62 to 100, and practically the product may be regarded as maltose.

If we take away the untransformed cane sugar existing in the twenty c.c. removed at the end of ten minutes, the product left represents the reducing power before and after treatment with sulphuric acid of 60 to 100; at the end of fifteen minutes 62 to 100; at the end of twenty minutes 66 to 100; at the end of thirty minutes 66 to 100; whilst he always stated at the end of forty-five minutes the figures stood as 62 to 100. There is here a slight discordancy existing, but nothing more than may be fairly presumed as falling within the range of liable error in the process of analysis; and, looking at the experiment altogether, it may be considered that the transformation did not advance beyond maltose, and that at the end of the time allowed some untransformed cane sugar still remained.

Experiment.—Some cane sugar solution was placed in a wide-mouthed bottle with some finely-divided intestine of a cat, and about 150 cub. centims. of water, and exposed to a temperature of 120° F. Portions of 20 cub. centims. each were removed at the periods mentioned below, and submitted to analysis, with the following results:—

At the end of five minutes.

	Cupric oxide reducing power expressed as glucose.
Before treatment with acid	0·030 grm.
After boiling with citric acid	0·045 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of fifteen minutes.

Before treatment with acid	0·033 ,,
After boiling with citric acid	0·042 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of thirty minutes.

Before treatment with acid	0·039 ,,
After boiling with citric acid	0·039 ,,
After boiling with sulphuric acid ..	0·060 ,,

At the end of one hour.

Before treatment with acid	0·039 ,,
After boiling with citric acid	0·039 ,,
After boiling with sulphuric acid ..	0·060 ,,

* A Paper read before the Royal Society, Dec. 20th, 1883.

At the end of two hours.

Before treatment with acid	0·039 grm.
After boiling with citric acid	0·039 ,,
After boiling with sulphuric acid ..	0·060 ,,

The results belonging to the above experiments may be read in the following way:—

At the end of five minutes the reducing power before treatment with acid was equivalent to 0·030 grm. of glucose, after boiling with citric acid to 0·045, and after boiling with sulphuric acid to 0·060. 0·015 grm. of untransformed cane sugar therefore existed, and this deducted leaves a product with the reducing power equivalent to 0·030 grm. of glucose before boiling with sulphuric acid and 0·045 grm. after. These figures stand in the relation of 66 to 100.

At the end of fifteen minutes the untransformed cane sugar had become reduced to 0·009 grm., and the figures left, after the deduction of this, stand in the relation before and after treatment with sulphuric acid of 64 to 100.

At the end of thirty minutes boiling with citric acid produced no alteration in the product. The figures were the same after as before; no untransformed cane sugar therefore existed. Boiling with sulphuric acid, however, carried the reducing power from the equivalent of 0·039 grm. of glucose to 0·060 grm. The relation of these figures is as 65 to 100.

At the end of one hour and two hours the condition was the same as at the end of half an hour. The ferment present, therefore, in half an hour had done its work, which was to leave no untransformed cane sugar, and to produce a body closely approaching in reducing power maltose, if it did not actually consist of maltose.

Experiment.—In this experiment a large quantity of ferment was purposely used. The ferment consisted of finely divided rabbit's intestine, and this was mixed with some cane sugar solution and about 300 cub. centims. of water and exposed to a temperature of 120° F. 50 cub. centim. portions were taken at the undermentioned periods for examination, and the following results obtained:—

At the end of seven and half minutes.

	Cupric oxide reducing power expressed as glucose.
Before treatment with acid	0·090 grm.
After boiling with citric acid	0·108 ,,
After boiling with sulphuric acid	0·186 ,,

At the end of fifteen minutes.

Before treatment with acid	0·120 ,,
After boiling with citric acid	0·120 ,,
After boiling with sulphuric acid	0·184 ,,

At the end of thirty minutes.

Before treatment with acid	0·150 ,,
After boiling with citric acid	0·150 ,,
After boiling with sulphuric acid	0·186 ,,

At the end of forty-five minutes.

Before treatment with acid	0·180 ,,
After boiling with citric acid	0·186 ,,
After boiling with sulphuric acid	0·184 ,,

At the end of one hour.

Before treatment with acid	0·186 ,,
After boiling with citric acid	0·186 ,,
After boiling with sulphuric acid	0·186 ,,

An illustration is afforded by this experiment of cane sugar being carried into glucose, and the intermediate stages are displayed.

At the end of seven and a half minutes there remained cane sugar equivalent to 0·018 grm. glucose, and the other product had a reducing power below that of maltose, the relation of its reducing power before and after treatment with sulphuric acid being as 53 to 100.

At the end of fifteen minutes there was no untransformed cane sugar, the reducing power being the same before boiling with citric acid as after, and the relation in the reducing power before and after boiling with sulphuric acid was as 64 to 100.

At the end of thirty minutes the reducing power of the product had advanced and stood as 80 before treatment with sulphuric acid to 100 after.

At the end of forty-five minutes there was so little difference between the figures before and after boiling with the acids that practically glucose existed.

At the end of one hour all the figures obtained were absolutely identical, and therefore indicative in literal manner of the presence of glucose.

The Portal Blood after Ingestion of Cane Sugar.

I have shown how cane sugar is moved when brought into contact with portions of the alimentary tract, and the nature of the principle into which it may be moved has been just discussed. Evidence is now required to be given of what physiologically occurs, and this is furnished by an examination of the portal blood.

By looking to the condition of the portal blood after the introduction of cane sugar into the stomach of a fasting animal information is supplied of the state in which the carbohydrate exists immediately subsequent to absorption. The following experiments in unmistakable terms show that it is not as glucose cane sugar enters the circulation. In both experiments the product encountered in the portal system possessed a cupric oxide reducing power below that of maltose.

Experiment.—One ounce (28 grms.) of cane sugar, dissolved in three ounces (85 cub. centims.) of water, was introduced into the stomach of a rabbit which had been last fed twenty-four hours previously. In half an hour's time the animal was killed, the abdomen instantly opened and portal blood collected. 27 grms. were obtained for analysis. The blood was poured into spirit in the usual way and the alcoholic extract evaporated down and treated with sulphate of soda.

The following were the figures yielded:—

	Cupric oxide reducing power expressed as glucose.
Before sulphuric acid	0·016 grm.
After ,, ,, ...	0·034 ,,

Relation 47 to 100.

Experiment.—30 grms. of cane sugar dissolved in 60 cub. centims. of water were, through an elastic tube passed down the œsophagus, injected into the stomach of a dog which had been previously subsisting upon a meat diet, twenty minutes afterwards the animal was killed and portal blood immediately obtained for analysis. 30 grms. were taken and treated with spirit. Subjoined are the figures that were yielded:—

	Cupric oxide reducing power expressed as glucose.
Before sulphuric acid	0·034 grm.
After ,, ,, ...	0·074 ,,

Relation 45 to 100.

Some of the same blood was subjected to examination for the presence of cane sugar by boiling with citric acid, and it was found that the figures obtained after the boiling with citric acid were the same as those before. No cane sugar therefore existed.

Appointments.—Mr. W. Popplewell Bloxam, F.C.S., of King's College, has been appointed Demonstrator in Chemistry at the Royal Naval College, Greenwich.—The Secretary of State for India in Council has been pleased to appoint Mr. David Hooper, F.C.S., of Birmingham, Analytical Chemist and Quinologist to the Government Cinchona Plantations, Nilgiri, Madras Presidency.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING MARCH 31ST, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, April 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 182 samples of water, the whole were, without exception, clear, bright, and well filtered.

The water supplied to the metropolis during the past month has differed but little in character from that supplied in February. The mean proportion of organic carbon was somewhat higher; but the maximum amount found in any particular sample fell short of the maximum observed in February.

During the past three months we have examined 546 samples of water drawn from the mains of the seven metropolitan companies taking their supply from the Thames and the Lea. They have all, without exception, been characterised by freedom from turbidity, and by a marked and increasing degree of freedom from colour.

Our own report on the quality of the water supply during the preceding month of February was on the whole favourable; only one sample out of the entire number examined being noticed as containing an excessive amount of organic matter. But in the report made to the Registrar-General on the results of the analyses of the water supplied to the metropolis during, as it is stated, the month of February, but in reality on the results of the analyses of one sample of each company's water all taken on the 1st day of February, it is alleged that the water supplied from the Thames by some of the companies "contained a very large proportion of organic matter," and that in the case of two of these companies the water "was thus considerably polluted." According, however, to the Reporter's own figures, the mean amount of organic matter in the five samples only of Thames-derived water, examined by him during (!) the month, was a little under four-tenths of a grain per gallon, and the maximum found in any one sample a little over five-tenths of a grain—a maximum falling far short of the one-thousandth part of 1 per cent of organic matter in the case even of the worst of two waters, both reported to be *considerably-polluted* by the presence of *a very large proportion* of organic matter.

The maximum of organic carbon and consequently of organic matter recorded in the February report to the Registrar-General, is substantially identical with that recorded by ourselves, and noticed by us as of exceptional occurrence; it being indeed not only the maximum of the month, but the maximum hitherto met with by us during the present year. On the other hand, the mean amount of organic carbon and consequently of organic matter recorded by the Reporter to the Registrar-General, from his examination of seven samples of river-derived water all taken on the 1st day of February, is very nearly double the mean amount recorded by ourselves from our examination of twenty-four samples of the water taken on successive days of the month.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PROUT'S HYPOTHESIS.

By V. H. VELEY, M.A. (Oxon.), F.I.C.

THE hypothesis of Prout concerning the relation of all the atomic weights to some one or more fundamental unit is generally admitted in principle, though the more refined stochiometrical determinations have tended rather to complicate than confirm it. The causes of its recognition are obvious: firstly, it satisfies a mental ideal, according to which all differences are ultimately to be reduced to harmonically related differences of numbers; and secondly, the established correlation of the atomic weights of the elements with their chemical function and physical properties has added an *à posteriori* confirmation of the probability of some such hypothesis.

There has recently appeared a paper by Gerber (*Bull. Soc. Chim.*, xxxix., 562—572) in which it is shown that if the elements are divided into four classes according to their dominant activity, there is for each class a common factor, simple multiples of which include all the known atomic weights. The following table contains the four factors d_1, d_2, d_3, d_4 for mono-, di-, tri-, and tetra-atomic elements respectively:—

	O=15·96.	O=16.
$d_1 = \frac{1}{16}$H	0·7673	0·7692
$d_2 =$ 2H	1·995	2·000
$d_3 = \frac{1}{2}[\frac{5}{16}$H]	1·5586	1·5625
$d_4 = \frac{5}{4}$H	1·247	1·25

Of these factors d_2, d_3, d_4 are in simple relation to one another, though the relation between d_1 and the others is not so obvious. However, there exists a more simple relation between four factors slightly different from the above, the multiples of which, on comparison, give numbers equally in accordance with those obtained by stochiometry. Between these numbers there is a constant logarithmic difference of 0·1.

$$\left.\begin{array}{l} d_1 = 0{\cdot}797 \\ [d = 1{\cdot}0] \\ d_4 = 1{\cdot}262 \\ d_3 = 1{\cdot}562 \\ d_2 = d_2 \end{array}\right\} \left\{\begin{array}{l} \text{log. } 1{\cdot}262 - \text{log. } 0{\cdot}797 = 0{\cdot}2 \\ \text{log. } 1{\cdot}562 - \text{log. } 0{\cdot}262 = 0{\cdot}1 \\ \text{log. } 2 \quad - \text{log. } 1{\cdot}562 = 0{\cdot}1 \end{array}\right\}$$
$$0{\cdot}1 = \text{log. } 1{\cdot}259$$

It will be necessary here only to adduce a few examples to trace out the relation between the atomic weights of some of the elements:—

24	$d_1 =$ 19	at. w. of F		8·8	$d_1 =$ 7	at.w. of	Li
44·5	$d_1 =$ 35·5	,,	Cl	28·8	$d_1 =$ 23	,,	Na
100	$d_1 =$ 80	,,	Br	49	$d_1 =$ 39	,,	K
160	$d_1 =$ 127	,,	I				
8·8	$d_3 =$ 14	,,	N	20	$d_2 =$ 40	,,	Ca
20	$d_3 =$ 31	,,	P	44	$d_2 =$ 88	,,	Sr
48	$d_3 =$ 75	,,	As	68·5	$d_2 =$ 137	,,	Ba

As Gerber has pointed out, in some cases an element can equally be classed g in two of the four divisions, for the terms of the progressions $n\,d_4$, $n\,d_3$, and $n\,d_2$ coincide frequently. For example—

28	$d_2 =$ 36	$d_3 =$ 56	at. w. g	Fe
59	$d_2 =$ 93·5	$d_4 =$ 118	,,	Sn
103·5	$d_2 =$ 164	$d_4 =$ 207	,,	Pb

Iron is both di- and tri-atomic; tin and lead, di- and tetratomic. If, then, there is a constant logarithmic difference between these elemental factors, the multiples of them will be in harmonic relation not only with one another, but with what we may call the basic number 1·260, the logarithm of which is 0·1.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

VANADIUM.

Roscoe's determination of the atomic weight of vanadium is the only one having any present value. The results obtained by Berzelius† and by Czudnowicz‡ are unquestionably too high; the error being probably due to the presence of phosphoric acid in the vanadic acid employed. This particular impurity, as Roscoe has shown, prevents the complete reduction of V_2O_5 to V_2O_3 by means of hydrogen. All vanadium ores contain small quantities of phosphorus, which can only be detected with ammonium molybdate; a reaction unknown in Berzelius's time. Furthermore, the complete purification of vanadic acid from all traces of phosphoric acid is a matter of great difficulty, and probably never was accomplished until Roscoe undertook his researches.

In his determination of the atomic weight, Roscoe‖ studied two compounds of vanadium; namely, the pentoxide, V_2O_5, and the oxychloride, $VOCl_3$. The pentoxide, absolutely pure, was reduced to V_2O_3 by heating in hydrogen, with the following results:—

7·7397 grms. V_2O_5 gave	6·3827 V_2O_3.	17·533 p. c. loss.
6·5819 ,,	5·4296 ,,	17·507 ,,
5·1895 ,,	4·2819 ,,	17·489 ,,
5·0450 ,,	4·1614 ,,	17·515 ,,
5·5296 grms. V_2O_3, re-oxidised gave	6·5814 V_2O_5.	17·501 p. c. diff.

Mean 17·509 ± 0·005

Hence V = 51·264 ± 0·025.

Upon the oxychloride, $VOCl_3$, two series of experiments were made, one volumetric, the other gravimetric. In the volumetric series the compound was titrated with solutions containing known weights of silver, which had been purified according to the methods recommended by Stas. Roscoe publishes his weighings, and gives percentages deduced from them; his figures, reduced to a common standard, make the quantities of $VOCl_3$ given in the third column proportional to 100 parts of silver. He was assisted by two analysts:—

Analyst A.

2·4322 grms. $VOCl_3$ =	4·5525 grms.	Ag.	53·425
4·6840 ,,	8·7505 ,,		53·528
4·2188 ,,	7·8807 ,,		53·533
3·9490 ,,	7·3799 ,,		53·510
0·9243 ,,	1·7267 ,,		53·530
1·4330 ,,	2·6769 ,,		53·532

Analyst B.

2·8530 ,,	5·2853 ,,		53·980
2·1252 ,,	3·9535 ,,		53·755
1·4248 ,,	2·6642 ,,		53·479

Mean 53·586 ± 0·039

The gravimetric series, of course, fixes the ratio between $VOCl_3$ and AgCl. If we put the latter at 100 parts, the proportion of $VOCl_3$ comes out as given in the third column:—

Analyst A.

1·8521 grms. $VOCl_3$ gave	4·5932 AgCl.		40·323
0·7013 ,,	1·7303 ,,		40·531
0·7486 ,,	1·8467 ,,		40·537
1·4408 ,,	3·5719 ,,		40·337
0·9453 ,,	2·3399 ,,		40·399
1·6183 ,,	4·0282 ,,		40·174

Analyst B.

2·1936 ,,	5·4039 ,,		40·391
2·5054 ,,	6·2118 ,,		50·333

Mean 40·378 ± 0·028

These two series give us two values for the molecular weight of $VOCl_3$:—

From the volumetric series ..	$VOCl_3$ =	173·096 ±	0·126
,, gravimetric ,, ..	,,	173·276	0·141
General mean	,,	173·177	0·094

Hence V = 51·104 ± 0·104.

Combining the two values for V we get the following result:—

From V_2O_5..	V =	51·264 ±	0·025
,, $VOCl_3$	,,	51·104	0·104
General mean..	,,	51·256	0·024

Or, if O = 16, V = 51·373.

AN ANALYSIS OF WATER FROM SALT WELLS, NEAR DUDLEY.*

By THOMAS TURNER, Assoc. R.S.M., F.C.S.,
Demonstrator of Chemistry, Mason College.

Salt Wells is not only of considerable local fame for the medicinal properties of its waters, but is also of interest as being the nearest saline spring in the immediate neighbourhood of Birmingham, and because it issues from the coal measures near to the outcrop of the "Thick Coal," about a mile and a half from the nearest Permian strata, while the better known neighbouring spas of Leamington, Droitwich, and Stoke are in the Trias.

The water issues in a pretty little wooded valley in Salt Wells Wood, about a mile south-east of Round Oak Station, on the Great Western Railway. Part of the water is passed through the heating apparatus and to the baths, while another portion is delivered by a pump, which, at the time the sample was taken, unfortunately had a loosely-fitting bucket, as a result of which the water was somewhat aërated before being collected. The sample was taken on July 10, 1883, the temperature being 12° C., and the specific gravity at 20°, after keeping a few days, was 1·0092. The water had no perceptible odour, but a decidedly saline taste. It was only very slightly turbid when collected, but the runnings from the pump left a reddish-brown streak, and in the course of two or three hours a bulky reddish-brown precipitate formed in the sample, although it was contained in a stoppered Winchester bottle which had been carefully tied.

Examination for Rare Substances.—A litre of the water was evaporated in a porcelain dish until crystals began to separate. These were removed as they formed, and the concentrated mother-liquor examined. Lithium and strontium were tested for spectroscopically by first fixing the position of a prominent line in their spectra, and then

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Poggend. Annal.*, 22, 14. 1831.

‡ *Poggend Annal.*, 120, 17. 1863.

‖ *Journ. Chem. Soc.*, 6, pp. 330 and 344. 1868.

* Abstract of article in the *Proceedings of the Birmingham Philosophical Society*, vol. iv., part 1, page 38.

searching for a corresponding line in the spectrum of the water residue. No indication was observed of lithium, strontium, or any element which had not previously been estimated, except barium.

A quantity of the mother-liquor was also tested for bromine and iodine. On the addition of chlorine the solution became orange, and on shaking up with ether a distinctly brown extract was obtained which, after washing with water, gave a yellow precipitate with silver nitrate, insoluble in nitric acid, but soluble in ammonia. The mother-liquor on being tested with dilute potassium nitrite, hydrochloric acid, and starch, did not give any indication, and as a single drop of a solution of potassium iodide containing but 0·05 per cent of the salt gave a distinct colour to the test, the absence of iodine was satisfactorily proved.

The results of the analysis may be conventionally represented as follows :—

Sodium chloride	10·4665
Calcium chloride	3·4639
Calcium carbonate	0·6062
Magnesium chloride	0·4671
Oxide of iron and alumina ..	0·0740
Silica	0·0382
Calcium sulphate	0·0303
Potassium chloride	0·0143
Sodium bromide	trace
Barium chloride	trace
	15·1605

Total solids 15·16 grms. per litre, or 1·516 per cent.

An analysis of this water was performed many years ago by Mr. J. T. Cooper, of London, though no details of the analysis are given. For purposes of comparison I have converted his results into the metric system. The first column contains the results obtained by Mr. Cooper, and the second my own.

Temperature	—	..	12°
Specific gravity (20°)	—	..	1·0092
Dissolved gases, per litre ..	86·5	..	78·99 c.c.
Consisting of { Carbon dioxide	84	..	59·97 per cent
Consisting of { Nitrogen ..	16	..	37·89 ,,
Consisting of { Oxygen ..	—	..	2·14 ,,
Composition of Deposit—			
Loss on ignition	—	..	16·57 ,,
Silica	—	..	5·00 ,,
Oxide of iron	—	..	78·26 ,,
Total Solids	1·103	..	1·516 ,,
Consisting of—			
Sodium chloride	61·76	..	69·038 ,,
Calcium chloride	23·68	..	22·849 ,,
Calcium carbonate	1·86	..	3·999 ,,
Magnesium chloride	9·31	..	3·081 ,,
Oxide of iron and alumina ..	—	..	0·488 ,,
Silica	—	..	0·252 ,,
Calcium sulphate	—	..	0·199 ,,
Potassium chloride	—	..	0·094 ,,
Sodium bromide	—	..	trace
Barium chloride	—	..	trace
Iron chloride	0·16	..	—
Iron carbonate	1·12	..	—
Magnesium carbonate	2·11	..	—
	100·00		100·000

It may perhaps be well to point out that from the mere chemical analysis of a saline water it would be unwise to draw any very definite conclusions either as to its medicinal value or as to the precise effect of any single constituent as an agent in the cure of disease. We may, however, compare Salt Wells spring with other and better known saline waters, such, for instance, as Stoke or Droitwich brine and sea water. We have then the following results :—

	Total Solids.	Common Salt.
Droitwich Brine	23·4	22·6
Sea Water	3·5	2 8
Salt Wells	1·5	1·0

We notice in the water from Salt Wells a considerable decrease in the proportional amount of sodium chloride present as compared with the other constituents, notably calcium chloride, and further, as one would naturally expect, we find that the saline springs of the coal measures, where exceptionally such do exist, are not so rich in dissolved mineral matters as are their neighbours in the Trias and Permian formations.

REPORT OF THE COMMITTEE ON INDEXING THE LITERATURE OF CHEMICAL ELEMENTS.*

The undersigned, a Committee appointed at the Montreal meeting of the American Association for the Advancement of Science, "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements, respectfully submit the following report.

The members have conferred with each other orally and by correspondence. Several plans have been suggested, and their merits discussed. Three methods of collecting material for the indexes may be named :—

1. Reviewing the Catalogue of Scientific Papers published by the Royal Society (8 vols., 4to).
2. Indexing special journals by different individuals, and collating the matter.
3. The independent plan, whereby each chemist indexes all the journals available to him with reference to a given element, in which he is presumably especially interested.

Each of these schemes is open to objections, and has its difficulties. The first would necessitate an enormous amount of clerical labour, for which volunteers would scarcely be secured; besides, data previous to 1800 could not be obtained from this catalogue.

The second involves, also, securing a large number of self-sacrificing volunteers; and both plans would require a vast amount of editorial work on the part of this Committee.

The third plan seems, to a majority of the Committee, the only feasible one at present. On the independent plan seven indexes have already been compiled.

The best arrangement of material has also been considered; and here again a threefold problem occurs :—

1. Chronologically.
2. Alphabetically, by authors.
3. Topically.

The committee do not venture to dictate to independent workers, but recommend the chronological arrangement, with the understanding that a topical index accompany each monograph.

The best channel of publication has also been considered by the committee. All the indexes hitherto published have been printed in the "Annals of the New York Academy of Sciences;" and the Academy has generously offered, through its officers, to continue its good work. The Smithsonian Institution further agrees to distribute, free of expense, all circulars and documents in furtherance of this undertaking; an offer which is of the greatest importance, and for which this committee expresses sincere thanks.

Since the appointment of the committee, Mr. Webb's Index to the Literature of Electrolysis has been published in the "Annals of the New York Academy of Sciences;" and several chemists have expressed a willingness to co-operate in the proposed undertaking. Prof. R. B. Warder

* From the *Proceedings of the American Association for the Advancement of Science*, Vol. 32, Minneapolis Meeting, August, 1883.

of Cincinnati has promised an index to the literature of the velocity of chemical reactions; Dr. Henry Leffmann of Philadelphia proposes to index the important element arsenic, and Professor C. E. Munroe offers a Bibliography of Explosives.—H. C. BOLTON, *Chairman*; IRA REMSEN; F. W. CLARKE; A. R. LEEDS; A. A. JULIEN.

CANTOR LECTURES OF THE SOCIETY OF ARTS.

THE first of the short course of lectures "On the Alloys used for Coinage" (an abstract of which has already been given in the CHEMICAL NEWS, vol. xlix., p. 131) dealt with the mechanical processes incidental to coinage.

In the second lecture Prof. Chandler Roberts traced the history of the changes in composition of the alloys which have from time to time been used. He pointed out that the meaning of the word "alloy" in Mint language is different from that ordinarily accepted in scientific phraseology, as it is applied to the base metal added to a more precious one, and not to the mass, which may be either molten or solidified, of the mixed metals. This use of the word has been fostered by the various Mint indentures, and it has, unfortunately, been perpetuated by the legislative enactment which now guides the currency—the Coinage Act of 1870. The word alloy is probably derived from the latin *ad-ligo*, to bind to, and the Italian metallurgist, Biringuccio, used the word with perfect accuracy in the 16th century. "I have told you," he says, speaking of the gold alloy, "that an alloy only signifies an intimate association (*damicabile amicitia*) of one metal and another."

From the Mint point of view the properties it is most desirable to secure in alloys are:—1st. Ductility; 2nd, Durability; 3rd, Uniformity of Composition. They must have exactly the degree of viscosity which will enable them to "flow" (as Tresca has shown) under pressure into all the fine lines of an engraved die, and they must be sufficiently rigid to enable them to retain the device imparted by the coinage press, for a coin of a soft metal like lead or pure gold would rapidly be reduced to the state of a mere counter by wear.

With regard to Greek and Roman coins, the analysis made by D'Arcet, Dr. Rauch, Lenormant, and by Dr. Flight, have afforded much information as to the composition of the coins of the ancients, and the researches of the above named authorities were referred to at length.

The "curve" of the gold and silver coinages of this country was then described, the co-ordinates being "standards of fineness" and dates of issue.

The gold "curve" begins at the year 1257, the 41st year of King Henry III., who coined pure gold. The standard now in use, 11-12ths pure gold and 1-12th of base metal (or expressed decimally 916·6) was adopted by King Henry VIII. With regard to the silver coinage Professor Roberts offered evidence in support of the view that the "old standard of England," which contains 925 parts of silver in the 1000, dates from Saxon times, and he appealed to the results of assays he has recently made of such early coins. He further showed that from the time of William the Conqueror to Henry VIII. the line of the curve is almost level and unbroken, but it is not a little singular that his assays of coins of King Edward the Confessor proved them to be "better" than standard, as they contained 945 parts of silver in the 1000. The "curves" representing the gold and silver coinages, although in the main continuous, show great "dips" between the reigns of Henry VIII. and Elizabeth, the critical period of our numismatic history at the worst part of which the silver coins only contained 1-4th of their weight of silver.

In conclusion it was pointed out that of all its ancient rights the governing body in the State alone preserves the privilege of issuing coins the intrinsic value of which is slightly less than the value at which they are current, and this right is strictly guarded by law and is only exercised in the public interest.

The questions dealt with in the third lecture did not relate to violent changes of standard, and did not comprise the history either of national disaster or success, but they had a special importance of their own, as they referred to the methods by which the standard fineness of alloys were recognised and maintained. The history of the various methods of assaying gold and silver from those officially adopted at the time of Pliny to the present day was then traced in detail, special attention being devoted to the gradual steps by which the minute accuracy that marks the present methods had been obtained. For instance, Geber, who wrote in the 8th century, gives, if mediæval translations of his works are to be trusted, a sufficiently accurate account of the method of the assay of silver by cupellation to enable the process to be conducted at the present day with no other aid than his, but his description more nearly corresponds to the cupellation of silver as conducted on a large scale with a view to extract silver from lead, than to a mere method of assay. It is interesting therefore to note that in the 12th century the assayer was instructed in conducting official trials of the coin to employ an entire pound weight, and it was not until the reign of King Henry VI. that a record is found of small quantities being taken for the trial; at this later period, however, about 12 grains, or nearly the amount used at the present day, was used.

Much new and interesting evidence as to the weights employed and the details of the methods used in times past was afforded by an examination of certain pieces of gold and silver found in Westminster Abbey, which proved to be the silver "buttons" and gold "cornets" actually resulting from the trials of the Pyx, since the time of Henry VII.

The work of Sir Isaac Newton was alluded to, and the furnace with which he is supposed to have cupelled silver in the Tower of London was exhibited. After the history of the method of assaying gold had been dealt with, Prof. Roberts showed how small a portion of the "remedy," or variation from the exact standards of weight and fineness allowed by law, is actually used at the present day in Mints.

He concluded by saying that these questions might appear to be somewhat abstract and unimportant, but that all questions connected with alloys used for coinage must have had a very vivid interest for those who lived at the period embraced between the reigns of King Henry VIII. and Queen Elizabeth, when the coinage was extremely debased; and at the present day the question was of hardly less importance, because vast commercial transactions were based on the integrity of the British gold coin.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, April 17, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—W. Alabaster, and E. L. C. Muspratt.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Dr. Miller and Mr. Louis, duly elected Fellows of the Society:—J. P. Battershall, W. D. Borland, J. C. Bose, W. D. Crumbie, A. F. Dimmock, H. G. Greenish, W. J. Grey, J. Gaskell, J. W. Pratt, A. G. Perkin, W. H. Perkin, jun., G. H. Wainwright.

Dr. PERCY F. FRANKLAND then read a paper on "*The Influence of Incombustible Diluents on the Illuminating Power of Ethylene.*" The present communication forms a sequel to a paper read by the author on the illuminating

power of ethylene when burnt with combustible non-luminous diluents (*Chem. Soc. Journ.*, Jan., 1884). In all cases the gases were consumed from a Referee's burner. Great care was taken to ensure the purity of the ethylene and the diluents (carbonic anhydride, nitrogen, oxygen, and atmospheric air) employed. The author records his observations in a series of tables and curves. He sums up the principal results as follows:—Mixtures of ethylene with the incombustible diluents, carbonic anhydride, nitrogen, aqueous vapour, and atmospheric air, possess a lower illuminating power than pure ethylene. In all mixtures of ethylene with either carbonic anhydride, nitrogen, or aqueous vapour, the intrinsic luminosity of the ethylene is reduced. In mixtures of ethylene with atmospheric air the intrinsic luminosity of the ethylene remains unimpaired until the air forms about 50 per cent of the mixture. Mixtures of ethylene with oxygen in insufficient quantity to form an explosive mixture, possess a greater illuminating power than pure ethylene; the intrinsic luminosity of the ethylene being greatly increased. The disilluminating effects of carbonic anhydride, nitrogen, and water vapour are due partly to dilution and partly to refrigeration, *i.e.*, the cooling occasioned by the introduction of inert gas into the flame; this refrigeration is proportional to the specific heats of the gases, but in the case of carbonic anhydride and aqueous vapour it is augmented by the absorption of heat which takes place in the dissociation of the aqueous vapour, and in the reduction of the carbonic anhydride to carbonic oxide. Of the four diluents, carbonic anhydride, nitrogen, aqueous vapour, atmospheric air, the first is the most and the last is the least prejudicial to the illuminating power; nitrogen and atmospheric air, however, become more equalised in their effects as the proportion in which they are present increases; complete disillumination of the ethylene being effected by the same proportion of each.

Mr. Cross then communicated a paper on "*Trichloro-pyrogallol*," by C. S. S. Webster. Messrs. Cross and Bevan found that by the action of chlorine upon lignose and bastose, chlorinated derivatives were obtained, similar in properties and composition to the derivatives obtained by the action of chlorine upon various astringent substances of natural origin, but while the latter are made up for the most part of compounds which are aromatic in the strict sense of the word, the former contain no compounds of this order but are converted into such under the action of chlorine. These authors also found that the amorphous chlorinated derivative from bastose had certain features of resemblance to the mairogallol of Stenhouse and Groves. The author of the present paper was therefore induced to re-investigate the formation of this mairogallol. He finds that the reaction by which it is formed is divisible into two stages, which can be separated. In the first a trichloro-pyrogallol is formed, and it is this compound which subsequently undergoes condensation to the C_{18} derivative in question. This body—

$$C_6Cl_3(HO)_33H_2O$$

was prepared as follows:—To 5 grms. of pyrogallol 12 c.c. of strong acetic acid are added; the mixture is kept cool, and a rapid current of dry chlorine is passed through; in about half an hour the new compound separates as a semi-solid mass of fine needles. The reactions of this body are almost identical with those of tribromo-pyrogallol, giving a deep blue colouration with baryta water, &c. The author has also prepared mairogallol, leucogallol, xanthogallol, and tribromo-pyrogallol, and confirms the statements of Stenhouse and Groves in almost every particular. He has, however, improved the yield of these substances by slightly modifying the original processes.

The Secretary then read the following papers:—

"*The Synthesis of Galena by means of Thiocarbamide*," by J. Emerson Reynolds. Some time since the author noticed that when sulphur urea was heated with an alkaline solution of lead hydrate the lead sulphide was thrown down in a specular layer. In the present paper he gives the best method of obtaining this specular coating on glass, brass, &c. Two solutions are used; one contains 90 grms. of sodium hydrate and 75 grms. of lead tartrate in a litre of water; the other contains 17 grms. of sulphur urea in a litre. Equal volumes of the two solutions are mixed and heated in a clean beaker at about 50°; a specular layer forms on the vessel, which is at first silvery and translucent; it thickens as the temperature rises and becomes opaque, resembling a brilliant face of a crystal of native galena. The excess of the sulphide separates out after boiling a short time as a very dense easily-washed precipitate, having the appearance of a very finely-powdered galena. The author hopes to be able to utilise this separation for analytical purposes. The coating adheres with considerable tenacity to glass, brass, &c., and when the patent rights which control the production of ammonium sulphocyanide lapse, this galena plating may be advantageously applied to many useful purposes. Two glass vases, one coated externally, the other internally, and a piece of brass tube plated with galena were exhibited.

Dr. Armstrong said the author gave no proof that this coating really consisted of galena, *i.e.*, crystallised lead sulphide.

"*On the Analysis of Woodall Spa*," by W. T. Wright. Woodall lies about midway between Lincoln and Boston. In 1811 a boring was made for coal which was abandoned at 277 yards, owing to the rising of a spring. This spring has since acquired some reputation as a medicinal remedy for gout, rheumatism, &c. The properties are apparently due to the bromine and iodine which it contains. The spring was analysed by Dr. Frankland in 1875. The author gives a very complete analysis of the water. It contains 11113·73 parts per million of chlorine, 49·7 of bromine, and 5·21 of iodine. The spring is much richer in iodine and bromine than any other in this country. The author also gives a short account of the geological structure of the district.

"*On the Critical Temperature of Heptane*," by T. E. Thorpe and A. W. Rücker. In a previous paper one of the authors carefully determined the superficial tension of heptane, which was in C.G.S. units at 0° 22·19. From this number the critical point of heptane was calculated to be 281°. Pawleski has shown that a constant difference exists between the critical temperature and boiling-points of strictly homologous compounds. This difference is in the case of hexane 182·3°. Normal heptane boils at 98·4°, which added to the constant 182·3° gives 280·7° as the critical point of heptane.

The Society then adjourned to May 1st.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académe des Sciences. Vol. xcviii., No. 10, March 10, 1884.

Mixtures of Detonating Gases. Calculation of Specific Temperatures and Heats.—MM. Berthelot and Vieille.—This memoir does not admit of useful abstraction.

Action of the Electric Effluve upon Oxygen and Hydrogen in presence of Chlorine.—P. Hautefeuille and J. Chappuis.—A mixture of oxygen and chlorine, both chemically pure, traverses an effluve-apparatus without being perceptibly modified. But if traces of nitrogen are added to the same mixture it leaves on the sides of the annular space a slight whitish deposit. This solid matter, if the action is prolonged, forms arborescent crystallisations like those of ice. It resists a temperature of 100°, but is rapidly decomposed without melting at 105°,

emitting hyponitric vapours. It consists of nitrogen, 9·01 per cent; chlorine, 22·71; and oxygen, 68·28. It is probable that bromine and iodine may in like manner combine with nitrogen and oxygen.

Formulæ of Certain Ammoniacal Salts.—R. Engel.—The author concludes that the metallic glyoxylates have the general formula $CH(OH)_2COOM$, and not, as is commonly supposed, CHOCOOM. To the acid alcohols of the formula—

$$\begin{pmatrix} CHOH \\ COOH \end{pmatrix}'$$

there corresponds a particular group of nitrogenous compounds which are neither ammoniacal salts nor amides.

Observations on a Memoir by M. Calmels on the Poison of the Batrachians.—MM. A. Gautier and Etard.—The authors express satisfaction that M. Calmels has confirmed the views put forward in their paper of June 12th, 1882.

No. 11, March 17.

Relative Speed of the Combustion of Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.—Nitrogen delays the combustion of hydrogen and of carbon monoxide, the former in the larger proportion. Mixed gases tend to burn separately, each at its specific rate. The speed of very hydrogenous gases closely approaches that of pure hydrogen, which seems to indicate that the hydrogen burns before the carbon, even in total combustions.

Theory and Practical Formulæ of Magneto-Electric Machines with Alternating Currents.—Felix Lucas.—A mathematical paper, not susceptible of useful abstraction.

On Hall's Phenomena.—A. Leduc.—If the magnetic intensity does not exceed a certain value we may represent the deviation of the equipotential line and of the lines of force at the point where they intersect it by the formula $D = kM(1 - at)$, k being the deviation produced at the temperature 0° in a point where the magnetic intensity is $= 1$, t being a constant which measures Hall's phenomenon in the metal, and a another constant. For bismuth a is very small; for silver its value is 0·008 to 0·009.

Laws of the Decomposition of Salts by Water.—H. Le Chatelier.—The author, referring to the law commonly admitted (see *Comptes Rendus*, June 17th and July 8th, 1872), declares it in absolute contradiction with the experiments of M. Schloesing on the decomposition of calcium and barium bicarbonates, whilst it establishes an analogy—*à priori* improbable—between the reactions by the dry and the moist way. The author seeks to show that we may explain all the facts observed by the ordinary laws of chemical equilibrium, in homogeneous liquid systems, by taking into consideration the insolubility of the compounds produced comformably to the laws of Berthollet,—*i.e.*, by admitting that the insoluble compounds eliminated from the field of the reaction no longer intervene in the state of final equilibrium, which is established exclusively among the compounds in solution. The law at present admitted leads us, on the contrary, to suppose that the equilibrium is established directly between the precipitated and the dissolved bodies.

Action of the Chlorinised Aldehydes upon Benzol in presence of Aluminium Chloride.—Alph. Combes.—The author proposes to apply the reaction of Friedel and Crafts to the chlorinised aldehydes in order to obtain different aromatic aldehydes. He commences this study with chloral. He has obtained one of the three aldehydes theoretically possible, $C_8H_7Cl_3O$.

The Addition of Iodine Chloride to Ethylene Monobromide.—Louis Henry.—The crude product is a very heavy oil, of a brownish colour. When purified it is a colourless liquid, which becomes coloured on exposure to light. Its density at 0° with reference to water is 2·53. Under the ordinary pressure it boils, with partial decomposition, at 193° to 195°,—a result in accordance with theory.

Relations between Plants and the Nitrogen of their Food.—W. O. Atwater.—Maize seems to utilise the mineral matter of manures readily and the nitrogen slightly, and to possess in a high degree the power of appropriating the nitrogen of natural sources. Whilst in its botanical characters it belongs to the cereals, in its physiological relations to plant-food it seems to have a much greater analogy with the leguminous plants. Potatoes are affected by each of the three fertilising agents, superphosphate, potassium salts, and nitrogenous compounds. But they yielded very moderate crops with mineral manures, and responded freely to the nitrogen of manures. Potatoes differ from maize as having less power of drawing sufficient quantities of nutritive elements, and especially of nitrogen, from natural sources. Oats have been still more sensitive than potatoes to the want of nitrogen.

No. 12, March 24.

Action exerted on Polarised Light by Solutions of Cellulose in Schweitzer's Liquid.—A. Levallois.—The author dissolved cotton in Schweitzer's liquid, and, having filtered the solution over asbestos, previously ignited, examined it with the polariscope, using the electric arc as a source of light. With a solution of the strength of 1 per cent he found a deviation of the plane of polarisation to the left equal to about 20°.

MISCELLANEOUS.

THE LABORATORY THAT JACK BUILT,

OR THE HOUSE THAT JACK BUILT ON CHEMICAL PRINCIPLES.

"A little nonsense now and then
Is relished by the wisest men."—*Dante.*

THIS is the laboratory that Jack built.

This is the window in the laboratory that Jack built.

This is the glass that lighted the window in the laboratory that Jack built.

This is the sand used in making the glass that lighted the window in the laboratory that Jack built.

This is the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the chlorine of yellowish hue, contained in the salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the sodium, light and free, that united with chlorine of yellowish hue, to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the atom that weighs twenty-three, consisting of sodium so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

This is the science of Chemistry that teaches of atoms weighing twenty and three, and of sodium metal so light and free, that united with chlorine of yellowish hue to form common salt, a molecule new, that furnished the soda that melted with sand compounded the glass that lighted the window in the laboratory that Jack built.

H. C. B.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bromine.—Professor Thorpe in his interesting lecture on the "Chemical Work of Wöhler" says—"We all know the story of the young chemist whose unscientific use of the imagination cost him the discovery of the element bromine." Will some correspondent of the CHEMICAL NEWS, or perhaps Professor Thorpe himself, give the circumstance alluded to for the benefit of some not acquained therewith?—H. C. B.

MEETINGS FOR THE WEEK

MONDAY, April 28th.—Medical, 8.30.
—— Society of Arts, 8. "Some New Optical Instruments and Arrangements," by J. Norman Lockyer.
—— Philosophical Club, 6.30 (Anniversary).
TUESDAY, 29th.—Institute of Civil Engineers, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Dr. Klein.
—— Society of Arts, 8. "The Transvaal Gold Fields; their Past, Present, and Future," by W. Henry Penning.
WEDNESDAY, 30th.—Society of Arts, 8. "The New Legislation as to Freshwater Fisheries," by J. W. Willis-Bund.
THURSDAY, May 1st.—Royal, 4.30.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar. Annual Meeting, 1.30.
—— Chemical, 8. "On Benzoyl-acetic Acid and some of its Derivatives," by W. H. Perkin, jun. "On Fluorene," by W. R. E. Hodgkinson.
FRIDAY, 2nd.—Royal Institution, 8. "Krakatoa," by Prof. Judd, 9.
—— Geologists' Association, 8.
SATURDAY, 3rd.—Royal Institution, 3. "Roman Archæology: the Forum," by Mr. H. M. Westropp.

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1275.

THE LATE JEAN BAPTISTE DUMAS.

ANOTHER of the few remaining *savants* who have been the contemporaries of Berzelius, Davy, Dalton, Gay-Lussac, and Biot, has passed away from our midst. On the 11th of April Jean Baptiste Dumas concluded his honourable and useful career. He was born at Alais, in 1800, and, like Liebig, he began his chemical career in the establishment of a pharmaceutist. Here, in his twentieth year, he entered upon physiological research, and published, in conjunction with Prevost, the results of a series of experiments on the blood. But, as M. Wurtz remarks, "pharmacy did not absorb him, and physiology could not retain him." He removed to Paris in 1821, devoted himself entirely to chemistry, and became the pupil of Gay-Lussac. He was soon in a position to undertake, successfully, the most important investigations. With him there began in chemistry a new development amounting almost to a revolution. The views then dominant had been founded exclusively upon the relatively simple study of mineral compounds. All compounds were supposed to be formed of two proximate elements, which might be either simple bodies or combinations of a lower order. The illustrious Swedish chemist, Berzelius, who in the earlier part of the century exercised an uncontested authority, had developed this dualistic hypothesis, and had based it upon his electrochemical hypothesis. In 1834, however, Dumas, studying the action of chlorine upon certain organic compounds, found that this element "possessed the singular power of combining with the hydrogen of such bodies, and of replacing it, atom for atom." This was the first announcement of a law which is now founded upon thousands of analogous facts, and which is the key-stone of the theory of substitutions. Laurent and Gerhardt ably assisted in the elaboration of this new doctrine. Berzelius opposed it from the very first with all the weight of his ability and his influence. The idea that an electro-negative element like chlorine could take the place of an electro-positive element like chlorine ran counter to his firmest convictions, and, in fact, was necessarily fatal to the entire dualistic system. It involved a new way of regarding chemical combinations. To Berzelius they had appeared as double entities; to Dumas they were unitary structures which might remain unshaken though a course of stones was replaced by other materials. This conception Dumas developed in a series of memoirs on chemical types, a notion which has since been simplified and generalised. In short, it must be admitted that in the creation of what has been called the new, or the post-Lavoisierian chemistry, Dumas played a great—perhaps the greatest—part. It is natural that such a transformation could not be effected without a prolonged and obstinate controversy, and we owe abundance of valuable investigations to the quest for arguments, on the one side to sustain, and on the other to refute, the new views.

This capital discussion, however, by no means sums up the scientific career of Dumas. We find him engaged with the re-determination of atomic weights and with the examination of the law of Prout. He improved existing analytical methods and may be pronounced one of the fathers of gas-analysis. He discovered also not a few organic compounds, which, as Professor Wurtz well remarks, are not isolated beings, but heads of families, the representatives of certain general properties or of certain functions. Thus, in 1830, he discovered oxamide, and in 1835 he studied wood-spirit, in conjunction with his pupil Peligot, and recognised its character as an alcohol.

To his early physiological researches we have already referred. But it must not be forgotten that in his lectures on organic chemistry at the Faculty of Medicine he treated the reactions of the animal economy from a general and an elevated point of view, balancing the losses and the gains and laying the foundations of the chemical statics of living beings. "These memorable teachings," says M. Wurtz, "have exerted a permanent influence, and have introduced into physiology exact methods."

In physics he will be remembered as the inventor of a new method for the determination of vapour densities.

As a teacher of chemistry he takes an exceedingly high rank. Soon after his arrival at Paris he opened a class at the Athénée. Subsequently, in conjunction with Lavallée, Ollivier, and Péclet, he founded the Central School of Arts and Manufactures, where he taught chemistry for more than twenty-five years. In 1832 he succeeded Thénard at the Polytechnique, and was called in the same year as "Adjunct Professor" to the Faculty of Science at Paris. In 1841 he became Titular Professor and Dean of Faculty. In 1844 he succeeded to the Chair of Organic Chemistry at the Faculty of Medicine. Here it was that his professorial career culminated. He was then in the most brilliant epoch of his creative activity. His hearers were fascinated at once with the grandeur and the novelty of his ideas, and with the eloquence and clearness of his exposition.

As may well be imagined, he was often consulted by the Government of the day whenever chemical or physical advice was essential. Before 1848, as Government Commissioner, he had to ascend the Tribune in the Chamber of Deputies, and explain the whole mechanism of coinage, with reference to a Bill before the Chamber. Notwithstanding the dryness of the subject the assembled deputies listened eagerly to a speech which lasted two hours. More recently he was a member of the Commissions on the international use of the metric system and on the establishment of electric units.

In addition to his very numerous memoirs in the *Comptes Rendus* and in other scientific journals, two of his works have become classical—the "Traité de Chemie Appliquée aux Arts," and the "Leçons de Philosophie Chimique," which M. Wurtz styles an "incomparable volume."

The honours which he well merited were not wanting. On the death of Flourens he was elected one of the perpetual secretaries of the Academy of Sciences. On the decease of Guizot he succeeded to his vacant chair at the Académie Francaise—a body which, though its members are for the most part inferior in intellect and in celebrity to those of the Academy of Sciences, is still regarded in France as the superior body.

In 1863 Dumas received from the Emperor Napoleon the Grand Cross of the Legion of Honour. In 1840 the Royal Society elected him a foreign member; in 1843 the same body awarded him the Copley Medal, and in 1869 the Chemical Society awarded to him the Faraday Medal.

At his funeral discourses were pronounced by M. le Compte d'Haussonville, on behalf of the Académie Francaise; by M. Bertrand, his fellow Secretary at the Academy of Sciences; by M. Rolland, President of the Academy of Sciences; by Professor Wurtz, as representative of the Faculty of Sciences and the Faculty of Medicine, of Paris; and by M. Melsens. But the researches of the late chemist are after all his true and his most eloquent eulogy.

Influence of the Density of Detonating Gaseous Mixtures upon the Pressure. Isomeric Mixtures.—MM. Berthelot and Vieille.—The authors conclude that up to the highest known temperatures, one and the same quantity of heat being imparted to a gaseous system, the pressure of such system varies proportionately as its density. The specific heat of gases is distinctly independent of the density, both at high temperatures and near 0°. The pressure increases with the quantity of heat imparted to one and the same system. The apparent specific heat increases parallel to this quantity of heat.—*Comptes Rendus*, No 10, 1884.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Continued from p. 182).

Analysis of Samarskite.

46. A very large quantity (about 15 lbs. weight altogether) of samarskite was worked up, partly by the hydrofluoric acid method of Lawrence Smith,† and partly by fusion with potassic bisulphate. The niobic and tantalic acids after purification were found to give no citron band spectrum.

These methods both gave as a result a large quantity of mixed earths containing most, if not all, of the bodies enumerated in par. 40. Tested in the radiant matter tube, this material gave the citron spectrum very brilliantly. It was dissolved in hydrochloric acid, neutralised as nearly as possible with ammonia, and boiled with sodic thiosulphate. This precipitated the thoria, zirconia, and alumina. In this precipitate some of the scandia might also be found, if present in quantity, but as scandic thiosulphate is not completely precipitated, and the earth is present only in minute traces, not much scandia, it is probable, was thus carried down.

This thiosulphate precipitate, treated in the usual way with sulphuric acid, gave no citron band in the radiant matter tube.

47. The filtrate from the thiosulphate was precipitated hot with excess of ammonia, and the precipitate after washing treated with sulphuric acid, dried, and heated till fumes of sulphuric acid disappeared. The sulphate, whitish with a very pale rose tint, was finely ground, and dissolved with frequent agitation in the smallest possible quantity of cold water—an operation which required much time. The solution was then precipitated with potassic sulphate, taking all necessary precautions to keep the liquid well saturated with potassic sulphate. This operation was allowed to go on for about ten days, when the precipitated double sulphates were filtered off and slightly washed with a saturated solution of potassic sulphate. The precipitate contained cerium, lanthanum, didymium, didymium β, decipium, samarium, scandium, yttrium α, yttrium β, together with any thorium and zirconium which might have escaped the thiosulphate treatment.

48. The filtrate from the double sulphates was precipitated hot with ammonia, which brought down the erbia, holmia, mosandra, terbia, thulia, ytterbia, and yttria. The small quantity of manganese in solution was in this operation completely thrown out.

49. The insoluble double sulphates (45) were dissolved in hydrochloric acid, precipitated hot with ammonia, washed till free from potassium salts, re-dissolved, precipitated as oxalates, ignited, and set aside for further examination. On testing in the radiant matter tube this mixture of oxides was found to be practically free from citron band.

50. The ammonia precipitate from the sulphates soluble in potassic sulphate (46) was well washed till free from potassium salts, and dissolved in excess of nitric acid. The concentrated solution gave an absorption spectrum showing lines belonging to erbium and allied metals. Having already proved that the body I was seeking was not one of those metals which gave an absorption spectrum (42, 43), my first object was to find some method by which I could roughly separate this mixture of earths into two portions, one giving absorption bands, and the other having no action on the transmitted spectrum. I found this was possible by taking advantage of the different solubility of the oxalates in nitric acid.

51. The highly acid solution of the nitrates was fractionally precipitated in the following manner:—

To the boiling liquid a solution of ammonic oxalate was added drop by drop. The precipitate at first formed redissolved on stirring. The cautious addition of ammonic oxalate was repeated until the precipitate refused to dissolve entirely, but left the hot liquid somewhat milky. It was then rapidly cooled with constant stirring, which brought down a heavy crystalline oxalate. This was filtered off, and called oxalate A. The filtrate, again heated to boiling, was precipitated in exactly the same way with a further quantity of ammonic oxalate till the hot liquid became opalescent. On cooling and stirring, a farther quantity of oxalate came down. The filtrations and precipitations were repeated until no more precipitate could be obtained. Usually I could get twelve or thirteen fractionations in this manner; towards the end the solution did not get milky, and it had to stand sometimes twenty-four hours before much oxalate came down.

52. The fractions first precipitated by oxalic acid gave very strong absorption bands when the concentrated solutions of the oxides were examined by transmitted light. The fractions last precipitated showed the absorption bands only faintly.

53. These operations gave me oxalates from A to L. These, ignited, with free access of air, were then each dissolved in nitric acid, and again separately fractionated as oxalates. The result was about 150 precipitates, ranging from $A_1\ A_2 \ldots A_{12}, B_1\ B_2 \ldots B_{12}$, to $L_1\ L_2 \ldots L_{12}$.

These, after ignition, were separated into five lots according to order of colour, and the fractionation of each of the five lots repeated as already described; the series of operations now closely resembling those of Pattinson's process for desilvering lead. This gave me about sixty lots. This time the hydrogen equivalent of the metal of each lot was taken by converting the oxalate into sulphate and estimating the sulphuric acid, assuming M_2O to be the type of oxide (40, note 1). The result was a series of earths having hydrogen equivalents (M) ranging from about 48 to 33. The earths were now sorted into high, low, and intermediate, those giving intermediate H equivalents being re-fractionated with repeated H equivalent estimation, the highest and lowest being each time separated and added to the former high and low lots.

54. The ultimate result of about five hundred fractional precipitations gave me a mixture of earths having an H equivalent M=48, and showing a strong absorption spectrum (56); a mixture having an H equivalent M=33, having no absorption spectrum (65); and intermediate earths.

In the radiant matter tube all these fractions gave the citron-band spectrum well, but that of the earth of lowest equivalent was much the brightest, and that of the highest equivalent the least intense.

55. Three methods are available for the partial separation of these earths and for the complete purification of any one of them. The formic acid process (56, 57) is best for separating terbia, as terbic formate is difficultly soluble in water, the other formates being easily soluble.

Fractional precipitation with oxalic acid (63, 64, 65) separates first erbia, holmia, and thulia, then terbia, and lastly yttria. This is the only method which is applicable for the separation of small quantities of terbia from yttria.

Fusing the nitrates (60, 68, 69) separates ytterbia, erbia, holmia, and thulia from yttria. It is not so applicable when terbia is present, and is most useful in purifying the gadolinite earths. This process is the only one known for separating ytterbia from yttria.

Selection must be made of these methods according to the mixture of earths under treatment, changing the method as one earth or the other becomes concentrated on one side or thrown out on the other. Each operation must be repeated many times before even approximate purity is attained. The operations are more analogous to the separ-

* From the *Philosophical Transactions of the Royal Society*, Part III., 1883.

† *Comptes Rendus*, vol. 87, p. 146.

ation of members of homologous series of hydrocarbons by fractional distillation than to the separations in mineral chemistry as ordinarily adopted in the laboratory.

Preparations of Pure Terbia.

56. The mixture of high equivalent earths (54) richest in terbia, erbia, holmia, and thulia was treated as follows:—

The earths were dissolved in dilute formic acid, and the solution heated for some time. A white powder of terbic formate separated. This was filtered off, the solution containing the more easily soluble formates evaporated to dryness, and ignited. In this way the M=48 earths were separated into two lots, one rich in terbia and the other rich in erbia, &c. The treatment with formic acid was again repeated on both lots, and the crude terbia finally purified as follows:—

57. The crude terbia from all the operations was systematically treated by the formic acid process, keeping the liquid so dilute that only a portion of the terbic formate separated out each time. The syrupy solution of formates was treated as described further on (60). The hydrogen equivalent of the terbium was taken each time; latterly it kept pretty constant at 49·5. The terbia was also tested in the radiant matter tube. At first the citron spectrum was very strong; gradually, however, it got fainter and fainter under the repeated formic treatment, until finally the spectrum became so weak as to satisfy me that it was due only to impurity in the terbia, and that, had the material been sufficient to stand against the extravagant process of purification adopted, I should finally have got a terbia giving no citron-band spectrum. (Subsequent examination (87) showed me that this terbia did not contain more than 1-5000th part of yttria).

58. A concentrated solution of the purest terbia obtained in this way, when examined by the spectroscope, showed no absorption lines whatever: proving the absence of erbium, holmium, and thulium.

59. The hydrogen equivalent (49·5) would not definitely show the absence of ytterbium (57·9) and yttrium (29·7); but these would have been separated by the formic acid treatment, terbic formate requiring 30 parts of water for its solution, whilst yttric and ytterbic formates dissolve in less than their own weight of water. Moreover, it was not probable that the terbia contained an appreciable quantity of any of these earths as an impurity, for neither the oxalic acid, the fusing nitrate, nor the formic acid process of fractionation produced any change in the atomic weight, 49·5.

Preparation of Mixed Erbia, Holmia, and Thulia free from other Earths.

60. The filtrate from the terbic formate (57), rich in erbia, and containing besides terbia, holmia, thulia, and yttria, was now treated by converting it into nitrates, evaporating to dryness, and submitting the mass to careful fusion, stopping the operation when the liquid mass began to evolve nitrous fumes. The erbic, holmic, and thulic nitrates decomposing before the yttric nitrate, extraction with water gave an insoluble residue rich in erbia, holmia, and thulia, and a filtrate rich in yttria. The insoluble residue was dissolved in nitric acid, again evaporated to dryness, and fused. These operations were repeated eight or ten times, with the result of raising the H equivalent of the erbium metals to about 56·8, but the citron-band spectrum remained strong for some time after. It, however, ultimately disappeared. A concentrated solution of this erbic, &c., nitrate showed a beautiful and intense absorption spectrum. I did not attempt any separation of erbium, holmium, and thulium from each other, as the evidence here obtained is sufficient to show that the element giving the citron-band spectrum is not one of these three metals. Likewise I had far too little material to enable me to enter on a work of such difficulty with any prospect of success.

Philippia.

61. The so-called philippia was sought for in the portion of earths intermediate between the terbia and yttria (54). These were dissolved in dilute formic acid, and the solution, filtered from some terbic formate which would not dissolve, was carefully evaporated down to a small bulk, filtering off the terbic or other difficultly soluble formates as they deposited. The clear concentrated solution was then set aside over sulphuric acid to crystallise. In the course of a few days brilliant rhombic prisms crystallised out, having exactly the appearance described by Delafontaine.* The finest of these crystals were picked out, dried on blotting-paper, and analysed. The hydrogen equivalent was found to be M=38·2. The citron-band spectrum in the radiant matter tube was very brilliant. The solution decanted from these crystals was evaporated to a syrupy consistency, filtered from insoluble terbic formate which deposited, and treated for yttria (65).

Some of the best rhombic crystals were added to cold water acidulated with formic acid, and gently heated, but all attempts to dissolve and re-crystallise them failed. A large quantity of an insoluble formate separated, and the mother-liquor on concentration again deposited shining rhomboidal crystals. On attempting to re-crystallise these, they again deposited an insoluble white powder. The mother-liquor was found to contain a large quantity of yttria, and the white insoluble formate on ignition gave an earth having the atomic weight and chemical behaviour of terbia. This entirely corroborates Professor Roscoe's conclusions,† that Delafontaine's philippia is nothing but a mixture of yttria and terbia.

Mosandra.

62. The chemical characters of this earth are so little known that I could not attempt to search for it. But as the citron band-forming earth always appeared concentrated amongst those whose double sulphates were most soluble in potassic sulphate,—and, of these, amongst those having the palest colour and lowest atomic weight,—it was scarcely conceivable that the earth I was in search of should ultimately prove to be one whose properties did not in any case correspond to these,—of a dark orange yellow colour, forming a difficultly soluble double potassic sulphate, and having the very high equivalent of M=51·2; these being the properties ascribed to mosandra by the discoverer, Professor Lawrence Smith.

Separation of Terbia and Yttria from Erbia, Holmia, and Thulia.

63. The mother-liquors, from which as much terbic formate as possible had been separated by the process above described (56, 57) were now evaporated down with nitric acid till all the formates were decomposed, and the highly acid solutions of nitrates were fractionally precipitated with oxalic acid (51, 52, 53).

64. The erbic, holmic, and thulic oxalates come down first; then the terbic oxalate; lastly the yttric oxalate (53). After repeated fractional precipitations I at last succeeded in obtaining a mixture of yttria and terbia of a golden colour, which gave a very brilliant phosphorescent spectrum in the radiant matter tube, but showed no trace of absorption band when the concentrated solution of the nitrates was examined in the spectroscope.

Separation of Terbia and Yttria.

65. The crude yttria was now added to the mixture of earths (54) having a hydrogen equivalent M=33, and the whole submitted again to fractionation with oxalic acid in a somewhat modified manner.

An excess of strong nitric acid was added to the solution of mixed terbic and yttric nitrates, and the solution was heated to the boiling point. Strong oxalic acid solution

* *Comptes Rendus*, vol. 87, p. 559; Chemical News, vol. 38, p. 202; *Journ. Chem. Soc.*, vol. 36, p. 116.

† *Journ. Chem. Soc.*, vol. 41, p. 277.

was added drop by drop till a faint permanent precipitate was produced. Strong nitric acid was now added, a drop at a time, till the solution again became clear, and the whole was allowed to cool very slowly without agitation. On cooling, an oxalate crystallised out in brilliant prisms. These contained nearly all the terbia with some of the yttria, whilst the mother-liquor contained most of the yttria with a little terbia. The filtrate was treated with more oxalic acid, a fresh crop of crystals being produced, when the crystals were ignited, and the resulting earths re-treated with nitric acid and oxalic acid. After repeated fractionations I finally obtained in this manner a perfectly white yttria and a terbia containing a small quantity of yttria. This terbia was added to the crude terbia from previous operations, and purified as already described (57).

These operations gave me two earths,—yttria and terbia,—which, from the constancy of their H equivalents, were taken to be pure. The earths giving absorption spectra and having H equivalents other than 29·7 and 49·5, include erbia, holmia, and thulia. This portion was not further examined for the purposes of this investigation.

(To be continued.)

NOTE ON THE EMPLOYMENT OF THE ABEL PETROLEUM TESTING APPARATUS IN TROPICAL CLIMATES.

By SIR FREDERICK ABEL, C.B., D.C.L., F.R.S., and BOVERTON KIDWOOD, F.C.S., F.I.C.

IT has been pointed out by one of us (*Journ. Soc. Chem. Ind.*, vol. 1., p. 473—478) that the method of testing prescribed by the Petroleum Acts of this country and India is liable to furnish, with one and the same sample of oil, lower results in a tropical country than in a temperate climate, unless certain precautions not specified in the legal directions for applying the test are observed. We found, for instance, that a sample of petroleum which gave a flashing-point of 73° F. when the test was made in the cool atmosphere of the laboratory, flashed on the first application of the test flame at 66° F. when the testing was conducted in an apartment heated to a tropical temperature.

Our earlier experiments led us to think that this difference was less due to the effect of the heated atmosphere upon the oil, during the performance of the operations involved in the process of testing, than to the oil having acquired, by prolonged exposure in closed vessels to a temperature above its flashing-point, a condition (not due, of course, to any chemical change) in which the more volatile hydrocarbons present were less readily held in solution by the hydrocarbons of comparatively low volatility, and were therefore more readily vapourised. We found that when the sample was subjected to prolonged cooling prior to testing, the tendency to exhibit a lower flashing-point was largely diminished. Our attention was afterwards directed to a statement by Dr. Lyon that in the use of the Abel petroleum testing apparatus in Bombay he found it necessary to adopt a special mode of procedure in order to avoid the occurrence of what he termed a *false flash*. The modification suggested by Dr. Lyon consisted in leaving the testing slide withdrawn for some time before commencing the application of the test-flame, and when experimenting under these conditions we found that the depression of the flashing-point was no longer distinctly shown.

It was, therefore, clear that the lower flashing-point was due, at any rate very largely, to vapour disengaged prior to the first application of the test-flame, and that this vapour became dissipated when the modification referred to was adopted.

As the result of further experiments, carried out with the valuable assistance of Dr. Kellner, and many of which were made with the assistance of Dr. Lyon, Chemical Analyser to the Government of Bombay, we expressed the following opinion in a joint memorandum addressed to the Secretary of State for India on June 11th, 1883:—

"The liability of petroleum oils to exhibit in tropical countries flashing-points as much as 6° to 7° F. lower than those furnished by the same oils in a temperate climate, which has been demonstrated by experiments at Woolwich and in India, is due to a great extent to the separation of vapour from the oil, consequent upon the agitation of the liquid when the cup of the test-apparatus is filled. The depression of the flashing-point may also be due in part to the effect of a tropical climate upon the oil, or upon the operation of testing."

With the contined assistance of Dr. Lyon we had ascertained the relative merits of various methods of overcoming this effect of a tropical climate upon the flashing-point. In addition to the plan already described, we found that the following methods were available:—

1. The removal ot the collected vapour by means of an aspirator, after placing the cover on the oil cup.

2. The dispersal of the vapour by gently blowing over the surface of the oil, after filling the cup and before putting on the cover.

3. The commencing of the application of the test-flame at a temperature considerably lower than that prescribed by the Acts.

The plan of blowing away the vapour we found simple and effectual in careful hands, but we did not consider it a desirable one to adopt, as it was obviously liable to abuse, and we, with Dr. Lyon, were ultimately led to give the preference to the method of commencing the application of the test-flame at a temperature of 56° F., when the first experiment has furnished a flashing-point below 73° F. The effect of this modification, as well as that of any one of the alternations above mentioned, is to gradually remove the vapour disengaged in the filling of the cup in successive quantities too small to give a flash, each application of the test-flame determining a current of air through the upper part of the cup, and sweeping out a portion of the gaseous contents.

Any one of the modes of operation above described is obviously open to the objection that it effects the removal of some small proportion of the most volatile constituents of the oil (which in all instances is a mixture of liquids differing, and in some cases very considerably, in volatility), and that consequently the character of the sample has sustained some alteration, tending to raise its flashing-point *before* the application of the test-flame is actually commenced. This is, however, unavoidable, and must even occur in tropical climates, to some extent, whenever a sample is subject to any kind of manipulation in the open air; the extent to which the flashing-point is thereby effected, is, however, unimportant in comparison with the value to be attached, from a commercial point of view, to the attainment of uniform results in the examination of cargoes of oils in different countries.

With the method of operating above specified, Dr. Lyon and ourselves expressed the confident opinion that oils, which it had hitherto been impossible to test satisfactorily in India, would furnish concordant results in the hands of different operators, and results not differing to any great extent from those obtained in a temperate climate with the particular oils tested. We did not, however, feel justified in leading the Trade to believe that the Abel test could, even then, be relied upon to give, in all cases, precisely concordant results in different climates; the tendency still being for the instrument to furnish lower flashing-points in a tropical country. We recommended, therefore, that the trade should provide for the liability of some samples to exhibit, when tested in India, a flashing-point as much as three degrees lower than the flashing-point recorded before shipment. It is quite possible that experience may show this to be an unnecessarily wide margin, especially if the flashing-point recorded by the examiner in India be the average of several results, for we believe that it is only in exceptional cases that any

material depression of the flashing-point will be apparent when the test is made by the modified method proposed.

We may point out that the amount of vapour disengaged in the filling of the cup obviously depends upon the precise mode of manipulation, and is, as might be expected, greatest when the oil is poured in slowly in a thin stream from a vessel held some inches above the cup. Under these conditions the considerable agitation to which the liquid is subjected acts mechanically in promoting the disengagement of vapour, while at the same time the attenuated volume of the liquid is exposed to a temperature much above the flashing-point of the oil; these circumstances may combine to cause a layer of vapour to cover the surface of the oil in the cup before commencement of the test. This has even been found to occur in the use of the Abel test in this country in summer weather. As we have already stated, prolonged exposure to a low temperature seems to reduce the tendency of the less volatile portions of the oil to become vapourised; we have not made any large number of experiments in this direction, because lengthened cooling is not a process which recommends itself for practical purposes.

ON THE

FLUID HYDROCARBONS OBTAINED BY THE COMPRESSION OF PETROLEUM GAS.

By GREVILLE WILLIAMS, F.R.S.

WHEN the gaseous hydrocarbons produced by subjecting petroleum to a high temperature are compressed into cylinders, as in the Pintsch system, so much employed for lighting railway carriages, a volatile fluid is condensed containing benzene, toluene, and certain olefines. I have been engaged in the examination of this mixture of hydrocarbons since October, 1882. As I find that Dr. Armstrong is working on the same subject, I think it desirable to give a brief outline of some of the results which I have obtained up to the present time.

The plan I have adopted for the separation of the olefines from the benzene and its homologues is as follows:—I first pass the vapours of the hydrocarbons through a powerful rectifying column. The portions distilling below 66° C. I put aside for the preparation of the olefines which I require for conversion into hydriodates, in order to continue work commenced by me in 1862 (*Journ. Chem. Soc.*, xv., 359). The portions distilling above 66° C. I use for the preparation of benzene and toluene. The olefines may be separated from the latter by agitating the hydrocarbons with a cold solution of permanganate of potassium, as shown by Berthelot; or, preferably, by distilling from dilute nitric acid. By this last method nitro-compounds are produced, which are now under examination.

The nitric acid process properly carried out yields results of considerable precision, the amounts of benzene and toluene obtained in repeated experiments being within one per cent of each other.

The specimens of the hydrocarbon from the various stations where the Pintsch process is carried out differ considerably in the amount of benzene and toluene they contain. Seven specimens with which I was favoured by Mr. Rickman, the Managing Director of the Pintsch Company, gave me the annexed numbers:—

Specimen.	Specific Gravity.	Percentage of Benzene & Toluene.
A	0·850	65·6
B	0·835	54·2
C	0·840	52·0
D	0·830	45·2
E	0·840	44·4
F	0·800	37·8
G	0·760	24·6

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ARSENIC.

FOR the determination of the atomic weight of arsenic two compounds have been studied; the chloride and the trioxide. The bromide may also be considered, since it was analysed by Wallace in order to establish the atomic weight of bromine. His series, in the light of more recent knowledge, may properly be inverted, and applied to the determination of arsenic.

In 1826, Berzelius† heated arsenic trioxide with sulphur in such a way that only SO_2 could escape. 2·203 grms. of As_2O_3, thus treated, gave a loss of 1·069 of SO_2. Hence As = 74·840. This is a close estimation; but, being drawn from a single experiment, has so little weight that it need not be included in our final general mean.

In 1845 Pelouze‡ applied his method of titration with known quantities of pure silver to the analysis of the trichloride of arsenic, $AsCl_3$. Using the old Berzelian atomic weights, and putting Ag = 1349·01, and Cl = 443·2, he found in three experiments for As the values 937·6, 937·1, and 937·4. Hence 100 parts of silver balance the following quantities of $AsCl_3$:—

56·029
56·009
56·016

Mean 56·018 ± 0·004

Later, the same method was employed by Dumas,‖ whose weighings, reduced to the foregoing standard, give the following results:—

4·298 grms.	$AsCl_3$ = 7·673	grms.	Ag.	Ratio 56·015
5·535	,, 9·880	,,		56·022
7·660	,, 13·686	,,		55·970
4·680	,, 8·358	,,		55·993

Mean 56·000 ± 0·008

The two series of Pelouze and Dumas, combined, give a general mean of 56·014 ± 0·0035, as the amount of $AsCl_3$ equivalent to 100 parts of silver. Hence As = 74·829 ± 0·048, a value closely agreeing with that deduced from the single experiment of Berzelius.

The same process of titration with silver was applied by Wallace§ to the analysis of arsenic tribromide, $AsBr_3$. This compound was repeatedly distilled to ensure purity, and was well crystallised. His weighings show that the quantities of bromide given in the third column are proportional to 100 parts of silver:—

8·3246 grms.	$AsBr_2$ = 8·58	grms.	Ag.	97·023
4·43368	,, 4·573	,,		97·022
5·098	,, 5·257	,,		96·970

Mean 97·005 ± 0·012

Hence As = 74·046 ± 0·058. Why this value should be so much lower than that from the chloride is unexplained.

The volumetric work done by Kessler,¶ for the purpose of establishing the atomic weights of chromium and of arsenic, has already been described in the chromium chapter. In that investigation the amount of potassium dichromate required to oxidise 100 parts of As_2O_3 to As_2O_5

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1.
‡ *Comptes Rendus*, 20, 1047.
‖ *Ann. d. Chim. et de Phys.*, (3), 55, 174. 1859.
§ *Philosophical Magazine*, (4), 18, 279.
¶ *Poggend. Annal.*, 95, 204. 1855. Also 113, 134. 1861.

was determined, and compared with the quantity of potassium chlorate necessary to produce the same effect. From the molecular weight of $KClO_3$, that of $K_2Cr_2O_7$ was then calculable.

From the same figures, the molecular weights of $KClO_3$ and of $K_2Cr_2O_7$ being both known, that of As_2O_3 may be easily determined. The quantities of the other compounds proportional to 100 parts of As_2O_3 are as follows:—

$K_2Cr_2O_7$.	$KClO_3$.
98·95	41·156
98·94	41·116
99·17	41·200
98·98	41·255
99·08	41·201
99·15	41·086
	41·199
Mean 99 045 ± 0·028	41·224
	41·161
	41·193
	41·149
	41·126
	Mean 41·172 ± 0·009

Another series with the bichromate gave the following figures:—

99·08	
99·06	
99·10	
98·97	
98·97	
Mean	99·036 ± 0·019
Mean of previous series	99·045 0·028
General mean	99·039 ± 0·016

Other defective series are given to illustrate the partial oxidation of the As_2O_3 by action of air. The foregoing figures give us two distinct values for the molecular weight of As_2O_3. In calculating from the bichromate results the value for chromium deduced from Siewert's determinations will be used, viz., $Cr = 52·009 \pm 0·025$.

From $KClO_3$ series.. ..	$As_2O_3 = 197·996$	± 0·049
„ $K_2Cr_2O_7$ „	„ 197·777	0·051
General mean ..	„ 197·894	0·035

Hence $As = 75·002 \pm 0·018$.

The general mean for As comes out as follows:—

From $AsCl_3$	$As = 74·829$	± 0·048
„ $AsBr_3$	„ 74·046	0·058
„ As_2O_3	„ 75·002	0·018
General mean ..	„ 74·918	0·016

If O = 16, then As becomes = 75·090.

ACTION OF *ASPERGILLUS GLAUCUS* ON CITRIC ETHER IN LEMON-JUICE.

By Dr. T. L. PHIPSON, F.C.S., &c.

LEMONS which are placed damp in a cupboard give out after a certain time a very strong odour of ether, which coincides with the development of *Aspergillus glaucus* upon them. When this microphyte penetrates into the interior, or covers the surface of a section of the fruit, the juice on being expressed has also a very strong flavour of ether.

I have been aware of this fact for a considerable number of years (though I have never seen it alluded to), and have often wondered how the ether is produced in these circumstances. But it was not until a short time ago that I observed its production always corresponded with the development of *Aspergillus glaucus* upon the lemons, for the little plant is not always detected at first by the eye alone.

Citric ether may exist in lemon-juice, as acetic ether, for instance, is known to exist in the sap of certain other plants. But citric ether has a very different composition from acetic ether, inasmuch as it contains three equivalents of ether to one of acid; and on being decomposed by *Aspergillus glaucus*, two of these equivalents are probably set free. Such at least is the interpretation I put upon the phenomenon, and this is what, I believe, occurs:—

Under the influence of warmth and moisture some of the *sugar* of the ripe lemon is *fermented*, and the *alcohol* formed immediately combines with the citric acid so abundant in the juice. Citric ether (triethylic citrate) is thus produced, which, under the continued influence of the *Aspergillus*, is split up into free ether and carbonic acid (with, probably, some intermediate products), so that as the action proceeds ether is volatilised into the air around.

In warm weather three or four lemons will thus diffuse a very marked odour of ether through the air of a large room which has remained closed for a few days.

In spite of their well-ascertained anti-fermentative properties, both citric and salicylic acids will in time succumb to the action of microphytes, as I have had many opportunities of observing. Salicylate of lime in solution in water to which dust has access develops a white microphyte in a few months at ordinary summer temperature, abundant filaments of which will be found covering undissolved crystals of this salt.

NOTICES OF BOOKS.

On the Discovery of the Periodic Law, and on Relations among the Atomic Weights. By JOHN A. R. NEWLANDS, F.I.C., F.C.S. London: E. and F. N. Spon, 1884.

IN this little volume the author has collected and arranged in chronological order all his contributions bearing on certain relations which he was the first to point out that exist between the numbers that Cannizzarro and others indicated as most probably representing the atomic ratios of the elements, and the chemical analogies of the bodies. A few years after the publication of these papers in the CHEMICAL NEWS the idea of arranging the elements according to their atomic ratios into groups or periods was put forth by Mendeleeff, the scheme being accompanied with a discussion of the chemical facts upon which the arrangement was based. Since the time when Prout endeavoured to show that the atomic weights of all the elements were whole multiples of that of hydrogen a not inconsiderable amount of "circle squaring" play has been indulged in by chemists in attempting to fit these numbers together in the fashion of a Chinese puzzle; as the result of these labours chemistry has not reaped any direct benefit. Indirectly, however, such speculations have done good by stimulating chemists to make more elaborate and exact determinations of the atomic ratios and to a more complete study of chemical analogies, and, more recently, to the properties of some of the rarer earth metals, as cerium, didymium, and lanthanum.

The idea of grouping the elements according to their atomic ratios was first stated by the author of this book, but it was more especially by the labours of Mendeleeff and L. Meyer that it has been raised to a rational hypothesis, and under the name of the periodic law the idea is now considered to be of sufficient validity and importance to merit its introduction into elementary text-books of chemistry.

Mr. Newlands' book has been published not so much

to expound his idea as to further establish his claim of priority as the originator of the periodic law; his claim has indeed been recognised by many writers on the subject, but perhaps in too slight a degree, and the incomplete manner in which the idea was given to the world rendered it eminently liable to be overlooked and ignored in this scrambling age. Mendeleeff, by taking a wide survey of all the chemical facts known relating to each individual element, pointing out the existing analogies between certain of the elements, elaborated the idea and wrought it into a shape acceptable to the scientific mind.

The first paper in the volume was published in the CHEMICAL NEWS for Feb. 7th, 1863, "On Relations among the Equivalents." Such of the elements as exhibit analogous chemical properties are grouped together and a few relations shown to exist among the equivalent weights of the members of each group. The chief points noticed are, the existence of triads in the several groups, that is, groups of three analogous elements, the equivalent weight of one element being the mean of the other two, which was noticed by Döbereiner, in 1829; and the fact that "if we deduct the member of a group having the lowest equivalent from that immediately above it, we frequently observe that the numbers thus obtained bear a simple relation to each other."

In the second paper on "Relations between Equivalents," published July 30th, 1864, a complete table is given of the elements, arranged in order of their equivalent weights, also a shorter one containing about half the known elements formed into natural groups, and the triads noticed. In this table lithium is grouped with magnesium, zinc, and cadmium, the three latter forming a triad; so too nitrogen, phosphorus, arsenic, antimony, and bismuth, from a group of which the three intermediate members constitute a triad. In the group of which boron forms the first member there are no three analogous elements given which might be considered as a triad; two of these blanks have since been filled by the discovery of indium and gallium, at least so the author tells us in his preface. In the next group, comprising carbon, silicon, and tin, the two latter are the extreme members of a triad, the mean position being blank. With regard to this arrangement the explanatory remarks contained in the paper state that "silicon and tin stand to each other as the extremities of a triad. Titanium is usually classed along with them, and occupies a position intermediate between silicon and the central term or mean of the triad, which is at present wanting; thus, $\frac{\text{Si } 28 + \text{Sn } 118}{2} = 73$ mean of triad, and $\frac{\text{Si } 28 + \text{mean of triad } 73}{2} = 50{\cdot}5$, the equivalent of Ti being 50." Thus, as the preface points out, twenty years ago the author drew attention to the missing link which Mendeleeff has predicted and named eka-silicium.

The most important papers contained in this volume bearing on the periodic law are those published in the CHEMICAL NEWS, August 18th and 25th, 1865, on the "Law of Octaves" and "on the Cause of Numerical Relations among the Equivalents," respectively. In the first note the elements are arranged into vertical series of sevens in order of atomic weights, the horizontal members forming a natural group. The elements are numbered 1, 2, 3, up to 56. The first vertical series from 1 to 7 comprises hydrogen, lithium, glucinum, boron, carbon, nitrogen, and oxygen; the second series, from 8 to 14, begins with fluorine, ending with sulphur, including the elements whose equivalents lie between these extremes. In this manner eight vertical series are formed; a few transpositions, however, are made in the consecutive numbering of the elements so as to bring analogous elements into the same horizontal row. Grouped in this fashion "it will also be seen that the members of analogous elements generally differ either by 7 or by some multiple of seven; in other words, members of the same group stand to each other in the same relation as the extremities of one or more octaves in music. Thus, in the nitrogen group, between nitrogen and phosphorous, there are 7 elements; between phosphorus and arsenic, 14; between arsenic and antimony, 14; and lastly, between antimony and bismuth, 14 also." This relationship the author provisionally named the "Law of Octaves."

The other paper consists of an endeavour to show that "all the numerical relations among the equivalents pointed out by Dumas and others, including the well known triads, are merely arithmetical results flowing from the existence of the 'Law of Octaves,' taken in connection with the fact of the equivalents forming a series of numbers approaching to the natural order." This last "fact," however, is far from being even allowable as a reasonable assumption, considering the possibility of "predicted" elements turning up. The elements here are again numbered consecutively, in order of equivalent weights, and as an illustration one of the consequences that follow from the arrangement is described in these words:—"Now, in conformity with the 'law of octaves,' elements belonging to the same group generally have numbers differing by seven or by some multiple of seven—that is to say if we begin with the lowest number of a group, calling it 1, the succeeding members will have the numbers 8, 15, 22, 29, 36, &c., respectively. But 8 is the mean between 1 and 15; 15 is the mean between 8 and 22; 22 is the mean between 15 and 29, &c., and, therefore, as an arithmetical result of the 'law of octaves' the number of an element is often the exact mean of those of two others belonging to the same group, and, consequently, its equivalent approximates to the mean of their equivalents." In a similar way it is shown how by this method some other numerical relations among the equivalents may be explained.

In an appendix to the work a few short papers are added, published since Mendeleeff's first contribution to the periodic law, containing more recent speculations on the subject and to vindicate the author's priority in the matter.

The main feature contained in these short papers is the idea of arranging the elements into groups of seven, to each group being allotted those elements which may be considered more or less analogous in chemical character; the way, however, in which this is done is based on too hard and fast lines, leaving little margin for future discoveries. That there should be only seven groups probably agrees best with our present knowledge, or occasionally admitting an eighth or long period, still it would be premature to attach too much value to the hypothesis, which may gain much strength or even fall by the discovery of one or two new elements, or some particular properties of those already known. Comparing the order in which the author of these papers grouped the elements together twenty years ago with the tables that have been drawn up in recent years by writers on the subject, making sufficient allowance for the considerable increase of our knowledge since then, one cannot help being struck by the great similarity between the schemes; indeed, so much so does this appear to us to be the case that we think had Mr. Newlands continued his speculations with the advance of science he might have made the subject all his own. As it is, to him is due the honour of first propounding the idea of periodicity among the elements, and surely the phrase "law of octaves" differs little from that of "periodic law" except by its special meaning. That Mendeleeff and Meyer indeed have done much, no doubt independently, to devise and develop the scheme no one can doubt, and our own Royal Society has amply honoured them for their labours. They more especially have laboured to show that the physical as well as chemical properties of the elements are periodic functions of the atomic ratios, and by so doing have given another auxiliary to the chemist to aid him in his researches. The discovery of gallium, and more recently of scandium, which were predicted, or more reasonably the finding that the atomic ratios of these elements, combined with their properties,

filled up certain lacunæ in Mendeleeff's table, have given the greatest interest to speculations concerning periodicity among the elements, and there is no lack of enthusiasts who see in the periodic law the basis of much further discovery. It has taught chemists that besides classing the elements into groups of somewhat similar bodies each element of these groups may be looked upon as a member of another distinct group of elements possessing among themselves quite distinct properties, and that in passing from one to the other of these last groups there is a recurrence or periodicity in the properties displayed.

The law cannot be said to be a numerical one, but what may be the views it will lead to regarding the constitution of matter, or whether it will even render the performance of one single experiment with a known element unnecessary, owing to the capacity for predicting phenomena which the amplification of the idea may acquire, can only be decided by a vast amount of experimental work for a long time to come.

Théories et Notations Chimiques. Premières Leçons du Cours professé à l'Ecole Polytechnique. Par Edouard Grimaux, Professeur à l'Ecole Polytechnique. Paris: Dunod. 1884.

There is certainly little cause for complaint, on the part of our elementary students of chemistry, of the insufficiency, in point of numbers, of small text-books on the science within their reach; but as to variety in the method of treating the subject, that is quite another thing. Supply in such a matter as book-making is exactly regulated by the demand for the same; and if it be the sole aim of the science-teachers at our schools to labour to impart the principles of chemistry under such a guise that may enable their pupils to grasp the idiosyncracies of some examiner or another, we cannot reasonably feel surprised at the kind of pabulum supplied through each stage of growth till the other side of the examination-room is reached.

There is a great deal of elementary matter connected with the fundamental principles of chemistry which we think could, with much advantage to the student, be introduced into our smaller manuals were the writers a little less anxious to compile a volume "to suit the requirements" of such and such a board of examiners, but more mindful of the hypotheses that underlie all formulæ.

This little book is well put together, and is intended as an introduction to the study of chemistry. In its scope, however, it is something more than an introduction, and to follow the author in his discussions through the various chapters requires some modicum of facts to assist the reader. Of the two parts into which it is divided the first contains, for an elementary work, a full and clear account of the fundamental hypotheses employed by the chemist. In the first few chapters the laws of definite and multiple proportion are explained and criticised, as well as the terms equivalent, proportional number, atomic and molecular weight. In the discussions of these matters Avogadro's hypothesis, Dulong and Petit's law, and the law of isomorphism are introduced, and the value of each of these hypotheses analysed in their application to the points in question, as well as the facts that have been brought to light by the study of the phenomena of dissociation. Newlands' and Mendeleeff's idea is explained, and the aid the periodic law offers to the classification of the elements; a chapter, too, is given to the much-discussed subject of atomicity.

In the second part an account is given of the different notations that have been proposed by Berzelius, Dumas, Gerhardt, and by Berthelot, and the alterations that have taken place in the values assigned to the atomic weights traced.

In an appendix Avogadro's paper on a method of determining the relative masses of the molecules of bodies, and the proportions according to which they enter into combination, as well as an extract from one of Ampère's papers, and another by Gaudin on molecules and atoms, are given.

The clear account which this little book gives of the theories and notations of chemistry is rendered more valuable by the historical aspect the author has given it.

CORRESPONDENCE

CURE FOR NITRIC ACID BURNS.

To the Editor of the Chemical News.

Sir,—Some weeks ago, in experimenting with "brown fuming nitric acid," I happened to splash a portion of this powerfully corrosive liquid upon the skin of the face. The pain caused, I need hardly say, was very acute, and in a few minutes an enormous blister arose upon the part affected. Copious application of cold water, then of such powerful bases as ammonia, potash, and lime in water, had no perceptible effect upon it, except perhaps to increase the violence of the inflammation. After a few minutes, however, I luckily bethought me to try the effect of a dilute solution of sulphurous acid, of which I had a good supply made but a short time previously. Assuming that the action of the strong nitric acid was an intensified process of oxidation, I cast about for a reducing agent which might safely be trusted to be innoxious, even if it did not afford much relief. The effect of its application was astounding. In a very few minutes the blister was reduced; the oxidising process of the strong acid was completely arrested, without having reached the roots of the hairs on the face; the painful irritation was completely removed, and in an incredibly short space of time the wound healed.

I do not write to suggest a repetition of such a painful though interesting experiment, but to record the result of my experience for the benefit of others.—I am, &c.,

A. Irving.

Wellington College, April 29, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 4, 1883.

On Electrolysis.—H. Schucht.

Qualitative and Quantitative Separation of Bismuth and Copper.—Dr. Julius Löwe.—Already inserted.

Preparation of Bismuth free from Arsenic and on the Atomic Weight of Bismuth.—Dr. Julius Löwe.—The process for obtaining a non-arsenical bismuth is described in detail at great length. The mean atomic weight of the metal is Bi=207·330 (if O=15·96) or 207·845 (if O=16·00.

Determination of Alcohol in Examinations of Beer by the Halymetric Method.—Dr. Kleinert.—This memoir does not admit of useful abstraction.

Wine Analysis.—Dr. J. Moritz.—The author determines total acidity with decinormal alkali, using rosolic acid as indicator; extract by the direct process; ash in the usual manner; glycerin according to Neubauer and Borgmann's method; alcohol by means of Geissler's vaporimeter, after a preliminary distillation; phosphoric acid by the uranium method in the ash of 100 c.c. of the sample; sulphuric acid direct in 50 c.c. of the wine after

acidification with hydrochloric acid; specific gravity by means of Westphal's balance and polarisation with Wild's polaristrobometer in a tube of 200 m.m. in length.

Determination of the Acetic Acid in Wine by Distillation with Watery Vapour.—Dr. B. Landmann.—This paper cannot be usefully reproduced without the accompanying figure.

On the Application of a Current of Air saturated with the Vapour of Bromine for the Precipitation of Manganese.—N. Wolff.—In the laboratories of iron works, manganese is generally separated from iron by repeated precipitation of the latter with sodium acetate. The manganese precipitated from the united filtrates by means of bromine contains alkali, and cannot be used at once for the determination of the manganese. This difficulty may be got over by using ammonium acetate instead of the corresponding sodium salt. The author uses instead of bromine-water a current of air saturated with bromine vapour. The formation of nitrogen bromide is then not to be feared; the precipitation of the manganese is complete; the possible impurities of the bromine do not affect the result, the consumption of bromine is smaller, and the process requires less time.

Behaviour of Silver Chloride, Bromide, and Iodide, with Bromine and Iodine.—Paul Julius.—Inserted in full.

A New Exsiccator Tap.—Paul Julius.

On a Reconstruction of Lintner's Pressure-Flask.—A. Gawalowski.

An Extraction-Apparatus.—A. Gawalowski.

Apparatus for Generating Gas.—Dr. P. Seidler.—These four papers describe improvements in apparatus which cannot be intelligibly described without the accompanying figures.

On Breaking-up Chrome Iron.— H. Schwarz.—The author protests against the statement of H. N. Morse and W. C. Day, that the silver crucibles used are rapidly attacked. The silver from which the crucible is made should be allowed to cool very slowly, so that it may not be rendered porous by "spitting." A well-made crucible will serve for at least 100 operations. The author allows the residue after lixiviation to be dried and slightly ignited; extracts the ferric oxide with hydrochloric acid and opens up again. If the chrome-ore has been previously well elutriated there is seldom more than a trace of chromic acid obtained in this second operation. The determination is effected by running the solution of potassium chromate into an acid solution of ferrous sulphate in excess, and titrating back with permanganate. An inversion of the process involves error, since chromic chromate is then easily formed and readily escapes reduction.

The Phosphorescence of Sulphur.—H. Schwarz.—Pale phosphorescent flames are often observed during the drying of gunpowder.

The Relative Proportions of Glycerin and Alcohol in Beer.—E. Borgmann.—The proportions fluctuate but little; the maximum observed was 5·497 glycerin to 100 alcohol, and the minimum 4·140.

Determination of Relatively Small Quantities of Alcohol in Glutinous Liquids.—E. Borgmann.—The author puts 100 to 200 grms. of the substance into a roomy flask, fitted with a cork having two perforations. In the one is a bent tube which merely passes through the cork and is connected at the other end with a condenser and a receiver. Through the other passes a tube bent at right angles, its longer end passing down nearly to the bottom of the flask, whilst the other is connected with any convenient steam-generator. The flask is fixed in a water-bath and by means of the current of steam all the alcohol is quickly driven out of the glutinous mass and into the receiver.

Tension of Mercurial Vapours.—Hagen and Hertz.—The authors give a tabular view of their results.

Examination of Spices.—E. Borgmann. — Tables showing the proportion of essential oils in different samples of pepper, cinnamon, mace, cloves, and pimento.

Action of Organic Acids upon Minerals.—H. Carrington Bolton.—From the Chemical News.

Spectral Analysis.—H. W. Vogel.—The author gives an explanation of the phenomena observed by Lockyer. He holds that the bright lines of incandescent gases may be modified in their position by the presence of other gases. Thus the differences in the spectra of certain bodies observed by Lockyer may be due to the presence or absence of other bodies.

On Photographing the Spectra of Sparks.—W. N. Hartley.—From the *Proceedings of the Royal Society*.

Method for Examining the Absorption of Light by Coloured Solutions —O. Tumlirz.—The liquid to be examined is placed in a hollow prism, with its refractive edge upwards, and running horizontally, in front of the vertical slit of the spectroscope.

Spectroscopes with Great Dispersion.—Ch. V. Zenger.—From the *Comptes Rendus*.

Improvements in Polarising Apparatus. — L. Laurent.—From the *Comptes Rendus*.—Similar improvements have been devised by F. Lippich and R. Landolt, and are figured in the *Zeitschrift für Instrumentenkunde*.

A Thermo Regulator.—F. P. Dunnington.—This instrument cannot be intelligibly described without the figures appended in the original.

An Instrument for the Correction of Gas-Volumes.—A. V. Harcourt.—From the *Proceedings of the Royal Society*.

An Apparatus for Observing and Measuring the Elimination of Oxygen from Green Plants.—T. Weyl.—This paper requires the accompanying figure.

Improvements in Balances and Weighing.—E. Brauer and Cuno Rumann.—For particulars we must refer to the original memoirs.

A Modification of the Pyknometer.—E. Wiedemann.—Air is expelled from pulverulent bodies not by boiling, but by means of the mercurial pump.

Manufacture and Correction of Burettes.—W. Ostwald.—From the *Journal fur Prakt. Chemie*.

An Improved Pipette.—A. Meyer.—The author has devised an arrangement suitable for poisonous or corrosive liquids.

On Experimentation in Fused Tubes—E. Drechsel.—From the *Journ. fur Prakt. Chemie*.

Preparation of Asbesto Filters.—P. Casamajor.—From the Chemical News.

Capsules of Asbestos Paper—J. Bering. — The moistened paper is moulded to the required concavity.

Removal of Residues of Precipitates from Glass Vessels.—A. Müller.—The author uses small tongue-shaped pieces of vulcanised india-rubber, supported by a stout wire inserted at the back.

Preservation of Oxygen Gas in Zinc Gasometers.—Julius Löwe.—The author recommends the use of lime-water instead of pure water.

Preservation of Hydrofluoric Acid and Fluorides.—E. Militz.—The author lines glass bottles with a layer of gutta-percha. He dissolves the gutta-percha in carbon disulphide, pours it into the bottle (which must be quite dry); allows the liquid to come in contact with all parts of the inner surface; pours out the excess, if any, and lets the bottle stand until the solvent has evaporated. Caoutchouc stoppers are required.

Preparation of Hydrobromic Acid. — Rother.—Bromine is allowed to act upon sulphur in presence of water. The sulphuric acid formed is neutralised with magnesia and the hydrobomic acid is distilled off.

Development of Sulphuretted Hydrogen.—J. R. de Luanco.—This paper requires the accompaning illustration.

Method for Obtaining Sulphuretted Hydrogen—J. Taylor.—From the Chemical News.

Detection of Arsenic in Undiluted Sulphuric Acid.—H. Hager.—The author places in a clean test-tube 3 to 4 c.c. of the acid and a little stannous chloride, shakes up well, applies heat, and boils for half a minute. If arsenic is present the acid takes a yellowish or brown colour; if the acid is pure it remains colourless. Nitric, nitrous, and sulphurous acid as well as organic matter must not be present.

Purification of Carbon Disulphide.—L. H. Friedburg and Obach.—From the Chemical News and the *Journ. fur Prakt. Chemie.*

The Electrolytic Deposition of Mercury, Tin, and Cobalt.—W. Gibbs.—From the Chemical News.

The Analysis of Silicates.—W. Knop.—This paper has been inserted in full.

Determination of Small Quantities of Sodium Chloride in Presence of Potassium Chloride.—G. Ulex.—The filtrate, after separation of the potassium chloride as the double platinum salt, containing sodium-platino-chloride and excess of platinum chloride, is mixed with a solution of sal-ammoniac. The ammonio-platinum salt is collected upon a filter, the filtrate evaporated to dryness, the volatile salts are expelled by heat, the residue extracted with water, the chlorine is determined by titration with silver, and the corresponding quantity of sodium chloride is found by calculation.

Determination of Titanic Acid.—P. T. Austen and F. A. Wilber.—An examination of the method of G. Streit and B. Franz, from the *Amer. Chem. Journ.*

Quantitative Determination of Zinc.—L. Schneider.—Zinc sulphate in aqueous solution up to 1 grm zinc in ½ litre water is almost entirely precipitated by sulphuretted hydrogen. The quantity remaining in solution is about 2 m.g. zinc per litre. At 1·7 grm. zinc. per ½ litre the precipitation is incomplete. In presence of free sulphuric acid the precipitation of zinc by sulphuretted hydrogen is perfect only when the proportion of hydrated acid does not exceed 1 c.c. per litre. Under the above-mentioned conditions as to concentration and acidity zinc may be separated by means of sulphuretted hydrogen from iron, manganese, nickel, and cobalt. From very dilute hydrochloric and nitric solutions zinc may also be completely precipitated by means of sulphuretted hydrogen. In accordance with the above facts the author determines zinc in its ores as follows:—1 grm. of the dry ore is placed in a long-necked flask with 10 c.c. sulphuric acid, and according as it is calamine or blende with 1 or 2 c.c. nitric acid, until white vapours of sulphuric acid escape. When cold the flask is placed in a sloping position, and 70 c.c. water are cautiously added. Roasted ores, and all such as are not soluble in nitro-sulphuric acid, are first dissolved in hydrochloric acid and then evaporated with sulphuric acid. Into the hot dilute solution there is passed sulphuretted hydrogen without previous filtration, and thus copper, arsenic, and antimony, free from zinc, are precipitated. After the gas has been passed in for 15 minutes it is heated to a boil, until the excess of sulphuretted hydrogen is expelled. The precipitate, consisting of the sulphides of the above-mentioned metals with lead sulphate and insoluble gangue-stone, is collected upon a filter and washed with sulphuretted hydrogen water. The filtrate which amounts to about 200 c.c., is mixed, boiling hot, with ammonia to incipient turbidity. The precipitate is re-dissolved with a few drops of sulphuric acid, and after the solution has been diluted with water to 500 to 600 c.c., the zinc is precipitated by means of sulphuretted hydrogen.

The Reduction of Solutions of Ferric Salts.—P. T. Austen and G. B. Hurff.—From the *Amer. Chem. Jour.*

Detection of Traces of Fluorine in Silicates.—W. Knop.—The finely-ground mineral is placed in a small tubulated retort, covered abundantly with sulphuric acid, and dry air is passed through, keeping the mixture at 50° to 60°. The gaseous current is caused to pass out to the bottom of a narrow glass cylinder, 20 c.m. in height, filled to about one-fourth with a solution of a few decigrms. of colourless aniline in 30 c.c. of a mixture of equal parts of aniline and ether. The current of air must be so regulated that a single bubble per second may pass through the aniline solution. If the current is thus kept up for two hours, if a small quantity of fluorine was present, there is found in the lower end of the delivery-tube as far as it dips into the aniline solution a white deposit. This may be easily removed with the feather of a pen and rinsed by immersion in the liquid. On adding 3 drops of a moderately strong solution of caustic soda in absolute alcohol the turbidity loses its crystalline glittering appearance, and within a quarter of an hour a cloud of sodium silico-fluoride settles to the bottom of the cylinder. The author believes that a milligramme of fluorine may thus be distinctly recognised.

Method for the Direct Determination of Chlorine in Presence of Bromine and Iodine, and of Bromine along with Iodine.—This paper will be noticed at some length.

Determination of Sulphur in Pyrites.—G. Lunge.—For effecting this determination in the wet way the author uses an aqua-regia of 1 part strong hydrochloric acid with 3 of nitric acid from 1·36 to 1·40 spec. gr. He finds on further examination that it is not advisable to use a nitric acid of above 1·42 spec. gr.

The Determination of Sulphur.—C. Bodewig.—Inserted in full.

Determination of Nitric Acid.—J. West-Knights.—From the *Analyst.*

The Spectra of the Carbon Compounds.—G. D. Liveing and J. Dewar.—From the Chemical News.

The Distinction of Primary and Secondary Amines and Phosphines from Tertiary.—H. Gal.—From the *Bulletin de la Soc. Chimique.*

Behaviour of Thymol and Carbolic Acid with Reagents.—E. Hirschsohn. — From the *Pharmaceutical Journal.*

A Sensitive Reaction of Phenol.—J. F. Eykman.—A very dilute solution of phenol mixed with a few drops of nitrous ether, and the same volume of undilute sulphuric acid, takes a red colour. If the acid is allowed to run down the side of the glass so as to form a layer below the phenol solution there appears a narrow red band where the liquids meet. This reaction indicates 1 part in two millions.

The Composition of Cacao Oil.—M. C. Traube.—The author has been unable to find the theobromic acid of Kingzett, nor indeed any other acid except the oleic, lauric, palmitic, stearic, and arachic.

Occurrence of Free Fatty Acids, rich in Carbon in Vegetable Fats.—E. Schmidt and H. Römer.—The authors find in these fats very considerable quantities of free acids.

The Detection of the Different Starches.—W. H. Symons.—From the *Pharmaceutical Journal.*

On α and β Amylan.—C. O'Sullivan.—From the *Journal of the Chemical Society.*

On Levulose.—MM. Jungfleisch and Lefranc.—From the *Comptes Rendus.*

Action of Potassa upon Glucose.—A. Emmerling and G. Loges.—The authors obtain a compound which reduces Fehling's solution in the cold.

On Andromedatoxine.—P. C. Plugge.—An account of a non-nitrogenous, poisonous compound obtained from *Andromeda japonica.*

Conversion of Ferric Hydroxide into Ferric Oxide.—C. Bodewig.—The author places the precipitate and the ash of the filter in a porcelain crucible, moistens with nitric acid, dries, and weighs, repeating these operations a second time. The oxide thus obtained is free from ferrous oxide, whilst pure pulverulent ferric oxide ignited for five minutes in an open, upright platinum crucible, over a small Bunsen flame, on solution in hydrochloric acid gave a blue precipitate with potassium ferricyanide. If the platinum crucible is placed slanting, half covered with its lid, reduction takes place also, though to a less extent. It is evident that the reductive gases of the flame diffuse themselves through the ignited bottom of the crucible.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Carbonate of Ammonia.—Can you, through your columns, give me any information, or tell me where I can get any information, as to the process of manufacture of commercial carbonate of ammonia? I believe it is made near Manchester in considerable quantities.—AMMONIA.

MEETINGS FOR THE WEEK

MONDAY, May 5th.—Medical, 8.30. Ann. Oration.
—— Society of Chemical Industry, 8. "On the Composition and Illuminating Power of Coal-gas," by Dr. Percy Frankland. "On the Estimation of the Illuminating Power of Gas Burners, especially those of large size," by W. J. Dibdin.
—— Society of Arts, 8. "Some New Optical Instruments and Arrangements," by J. Norman Lockyer.
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 6th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Photographic, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
WEDNESDAY, 7th.—Society of Arts, 8. "Bicycles and Tricycles," by C. V. Boys.
THURSDAY, 8th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
—— Society of Arts, 8. "Cupro-ammonium Solution and its use in Waterproofing Paper and Vegetable Tissues," by C. R. Alder Wright.
FRIDAY, 9th.—Royal Institution, 8. "Mohammedan Mahdis,," by Prof. W. R. Smith, at 9.
—— Society of Arts, 8. "Indigenous Education in India," by Dr. G. W. Leitner.
—— Astronomical, 8.
—— Quekett Microscopical Club, 8.
SATURDAY, 10th.—Royal Institution, 3. "Roman Archæology: the Palatine Hill," by Mr. H. M. Westropp.
—— Physical Society, 3.

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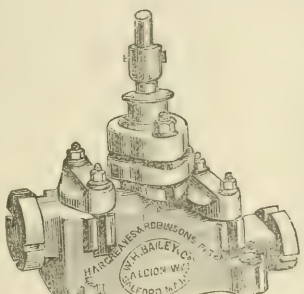

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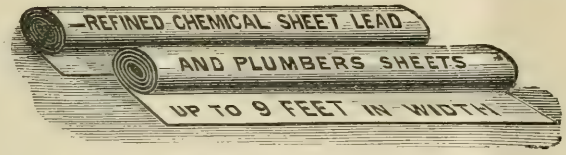

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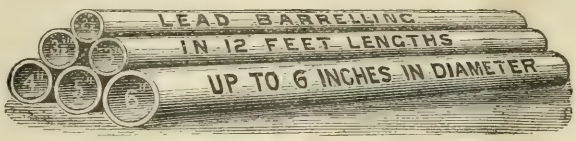

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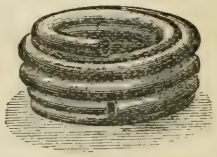

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1276.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: THE DETECTION AND WIDE DISTRIBUTION OF YTTRIUM.*

By WILLIAM CROOKES, F.R.S.

(Concluded from p. 196).

Ytterbia.

66. Before considering it finally proved that the substence forming the citron-band spectrum was yttria, it was necessary to prepare ytterbia and ascertain its behaviour in the radiant matter tube, this earth and yttria being the only remaining earths to which the citron spectrum could possibly belong.

The two metals have hydrogen equivalents—ytterbium 57·9 and yttrium 29·7. The chemical reactions are also sufficiently different to render their separation a matter of no very great difficulty.

67. Gadolinite is said by Nilson to contain most ytterbia, so this mineral was chosen in preference to samarskite. The crude earths were first purified from all the earths whose sulphates are difficultly soluble in potassic sulphate (22, 25, 31 to 36), then by the formic acid process from terbia (56, 57), and lastly by fractional precipitation with oxalic acid from the erbia earths (65). There remained an almost white yttria, which gave the citron-band spectrum very brilliantly. Now, gadolinite contains only about 0·1 per cent of ytterbia, and about 35 per cent of yttria; therefore the ytterbia to yttria in this mixture was somewhat in the proportion of 1 to 300, and it gave the citron-band spectrum as brilliantly as I had ever seen it. The probability was that the earth forming nearly the whole was the one giving the spectrum.

68. Ytterbic nitrate decomposes on fusion almost as easily as erbic nitrate (60), whilst yttric nitrate resists decomposition much more energetically.* Fusion of the nitrates is also the best process for throwing out the erbia, holmia, and thulia, and is therefore the best for purifying gadolinite yttria, as this mineral is rich in the erbia earths and contains little terbia.

The gadolinite yttria was converted into nitrate, fused for a short time, and extracted with water. The portions soluble and insoluble in water were again separately submitted to this treatment, until at last a colourless earth was obtained, the nitrate of which decomposed easily on fusion, and another whose nitrate resisted decomposition when exposed for a long time to nearly a red heat (70).

The earth from the easily decomposed nitrate gave at first a faint citron-band spectrum, evidently due to impurity. On repeating the operation several times I at last succeeded in obtaining a white earth which gave only the merest trace of citron-band spectrum. Its hydrogen equivalent, 58·0, and its chemical properties showed that it was probably Marignac's ytterbia. Subsequent experiments satisfied me that this earth did not contain more than 1-10,000th part of yttria (84, 87). The extreme tediousness of the chemical operations necessary to obtain this high degree of purity, and the long time they require, prevented me from pushing these results beyond what was necessary to prove the special point at issue.

* Marignac, *Comptes Rendus*, vol. 90, p. 902.

Purification of Yttria.

69. The white earth obtained in the operation described at par. 65 might still contain traces of terbia, together with erbia, holmia, and thulia. I had relied on the absence of absorption spectrum as proving the absence of erbia, holmia, and thulia, but this test is not a very delicate one, and a final purification was therefore attempted. The decomposition of the fused nitrates was now the process relied on for this final purification, the yttric nitrate resisting nearly a red heat without decomposition, whilst the erbic, holmic, and thulic nitrates are decomposed at a much lower temperature. The operation was carried on as described at par. 60.

The yttric nitrate left undecomposed, after repeated fusions, was now fused at a higher temperature, extracted with water, filtered from insoluble residue, and the operation repeated on the filtrate. After several such operations the H equivalent of the yttria was taken at every succeeding operation, and the spectral appearance in the radiant matter tube was also examined. The equivalent gradually got down to 31·0, but the spectra did not vary very much; that from the earth of lowest equivalent being, however, the most brilliant.

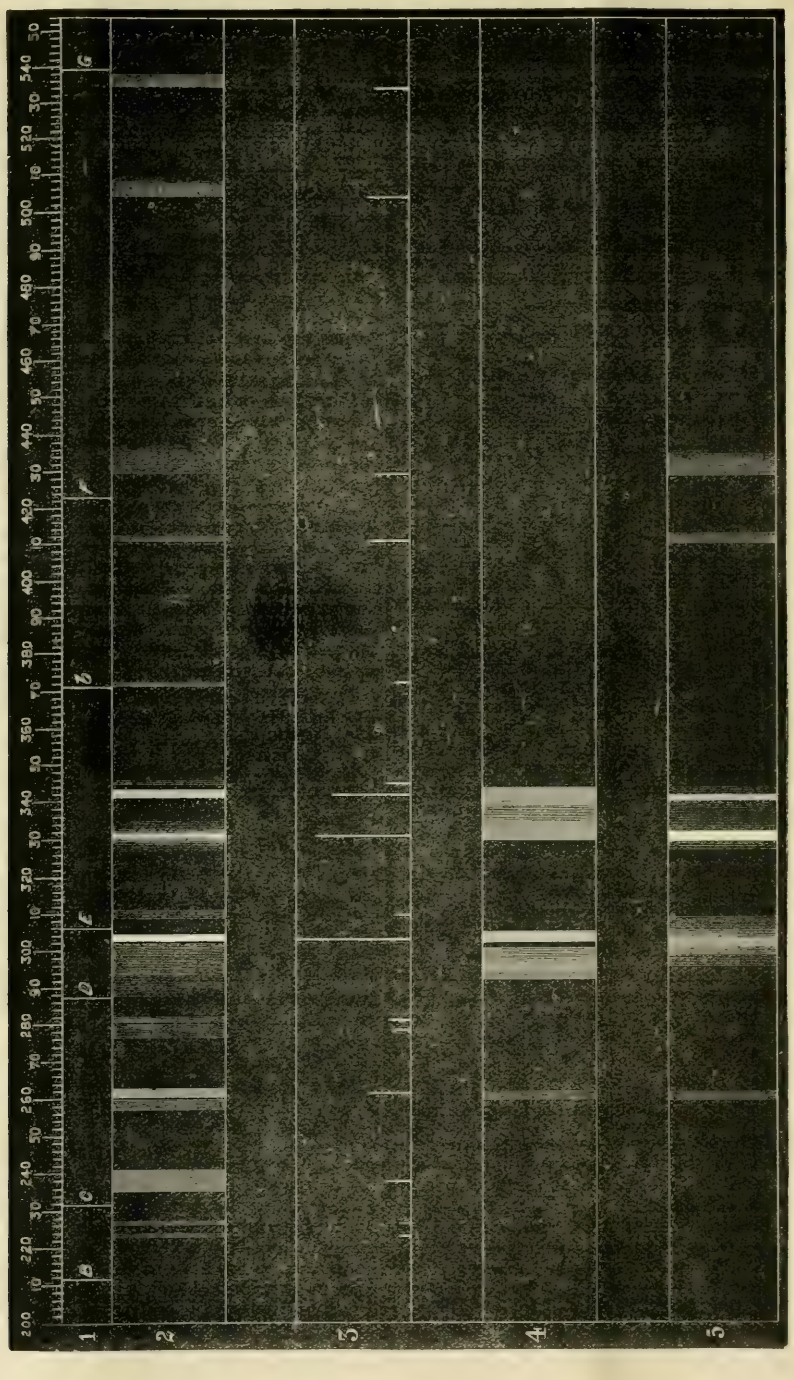
70. The yttric nitrate, prepared from gadolinite and freed from ytterbia by the fusion of the nitrates (68), was converted into oxalate and ignited. The resulting yttria was quite white, and on testing in the radiant matter tube gave a spectrum absolutely identical with that given by the zircon (18), cerite (25), thorite and orangite (33, 34), and samarskite (64, 69), yttrias. Pure yttria was also prepared from yttro-tantalite, euxenite, allanite, tyrite, and also from plaster of Paris (15) and common limestone. In no case could I detect any difference in the position or intensity of the lines shown by their phosphorescent spectra.

The Phosphorescent Spectrum of Yttria.

71. The spectrum shown by pure ignited yttric sulphate in a radiant matter tube is one of the most beautiful objects in the whole range of spectroscopy. The lines are not so sharp as those given by spark spectra, but are more like the flame spectra of the alkaline earths. The spectrum is best seen under low dispersion and not too narrow a slit. The accompanying cut gives an accurate map of the spectrum. I have given in line No. 1 the position of the principal Fraunholer lines for comparison of position. Line No. 2 gives the position of the bands, and No. 3 the relative intensities represented by the heights of the ordinates. The numbers along the top refer to a scale of squared oscillation frequencies, or of the squared reciprocals of wave lengths.

72. Commencing at the red end, two narrow faint bands are seen at 2245 and 2275, followed by a stronger and broader red band extending between 2355 and 2415. Another faint band occurs between 2577 and 2610, followed after a very narrow black interval by a stronger reddish orange band extending to 2627. Another faint orange band occurs at about 2800, with edges too indistinct for measurement. At about 2940 a faint yellow band appears, extending to about 3025. The strong citron-coloured band follows closely from 3028 to 3049; and a little further on, between 3100 and 3120, a much fainter citron band is seen. Two characteristic green bands follow after a dark interval; the first, very bright, extending between 3312 and 3320, but shading off on each side; the second somewhat fainter, but more sharply defined than the first, extending from 3420 to 3440; there is also a third faint green band, between 3460 and 3467. At 3730 is the centre of a narrow and faint bluish green band; at 4110 to 4125 in a blue band; and at 4296 another blue band commences, and, extending a short distance, fades away so gradually as to render measurement of the further side impossible. At 5052 and 5351 are two violet lines, but they are not sufficiently sharp to enable accurate measurements to be taken.

I have carefully compared the spark spectrum given by yttric chloride with the phosphorescent spectrum, and have not found any similarity between them, neither have I de-



tected any discontinuity of spectrum on examining the faint light shown by yttrium compounds in Becquerel's phosphorescope.

73. The above description applies to the spectrum shown either by pure yttria or by an earth tolerably rich in yttria. When traces are present the citron band only is seen. A little more yttria brings out the first and then the second green band, and finally, as the proportion of yttria increases, the red and blue bands appear (80 to 86).

Circumstances modifying the Yttria Spectrum.

74. In the early days of this investigation I frequently found that an earthy mixture which by one mode of treatment gave no spectrum, would give a good citron band by a modification of the treatment, and I gradually found that I was most likely to get the spectrum when the body had been treated with sulphuric acid and then ignited to dull redness (4). Not knowing the circumstances govern-

ing the appearance of the citron band, it would not then have been safe to have altered this mode of treatment. Now, however, having ascertained the earth to which the spectrum was due, and having a considerable quantity at my disposal, experiments were tried on other methods of treating yttria before exposing it in the radiant matter tube.

75. Pure yttria precipitated by ammonia from the sulphate was dried at a temperature below redness and tested. It did not phosphoresce in the slightest degree, and, necessarily, no citron-band spectrum was to be seen. The yttria was removed from the tube, converted into sulphate, heated to redness, and again tested. It now gave the citron band magnificently. This shows what apparently trivial circumstances will alter the whole course of an investigation. In 1881, when searching for discontinuous phosphorescent spectra, I tried a similar experiment with pure precipitated yttria (45), and entirely missed its citron-band spectrum. Had I first treated the yttria with sulphuric acid, instead of testing the earth itself in the radiant matter tube, the results would have been very different, and this research would probably have never been undertaken.

76. Yttria was now prepared by igniting the precipitated oxalate at a red heat. On testing in the radiant matter tube it phosphoresced with feeble intensity, the light being about one-twentieth of that given by the ignited sulphate under similar conditions. The citron band was almost as sharp as the sodium line, and was shifted one division towards the blue end, now occupying the position 3050 to 3060, its former place 3028 to 3049 being quite dark. The appearance is shown in line No. 4. On superposing this spectrum and that from the ignited sulphate the displacement of the citron bands was clearly observed; with a very narrow slit the two bands were seen not to touch. The two green bands were visible, but very hazy and indistinct, and only to be resolved into bands with difficulty. The yttria was now removed from the tube, ignited to a bright red heat, and re-tested. The spectrum was a little stronger than that given by the yttria ignited at a lower temperature, but in other respects the general appearance and measurements were unchanged. No alteration was caused by subsequent ignition to a white heat.

77. Pure yttric sulphate ignited to a bright white heat gave a spectrum corresponding to the oxide (76); the sulphate having been decomposed by the high temperature.

78. Yttric phosphate was precipitated, washed, and dried at a heat below redness, and introduced into the radiant matter tube. It phosphoresced faintly, giving the citron band hazy and faint, extending from about 3010 to 3060. The red bands were faint, and the green bands, especially the first one, were stronger than usual. The salt was now removed from the tube, and heated to redness. It became of a grey colour, and now phosphoresced with a beautiful green light. The citron band was still broad and faint, but the green bands were very bright and distinct, and the red band between 2610 and 2627 was also stronger. The spectrum No. 5 shows the appearance.

Heating the phosphate before the blowpipe made little change in the character of the phosphorescence. It was moistened with sulphuric acid, heated to a dull redness, and then tested, but no further change was produced in the spectrum. This experiment shows that the citron-band test for yttrium is far less delicate in the presence of phosphoric acid than in its absence.

Occurrence of Yttria in Nature.

79. It is an old and probably a true saying that every element could be detected everywhere had we sufficiently delicate tests for it. Early observations (10, 16) had prepared me for the wide distribution of the element giving the citron band, and no sooner had the exquisite sensitiveness of this spectrum test forced itself on my notice than I sought for yttrium in other minerals. Facts which I had noticed in connexion with the variation of the appearance of the citron spectrum, according to the quantity of yttrium present, showed that it might be possible to devise a process for the rough quantitative estimation of yttrium, and after several experiments this was ultimately carried out in the following manner:—

The calcic carbonate which was found to give no citron band (12) was boiled in a quantity of nitric acid insufficient to dissolve it. The solution was filtered from the insoluble residue, diluted to a convenient bulk, and standardised: 14·91 grains of solution contained 1 grain of calcium. This operation was performed in a room in which had been no yttria compound, and the chemicals and apparatus were new, and had not been taken into the general laboratory. A portion of the standard solution was precipitated with ammonic oxalate, and the calcic oxalate ignited and treated with sulphuric acid. Tested in the radiant matter tube it gave no citron band.

Pure yttric sulphate was dissolved in water to such a strength that 3000 grains of solution contained 1 grain of yttrium.

80. The solutions were mixed together in the proportion of 1 of yttrium to 100 of calcium, evaporated to dryness, and ignited with sulphuric acid, and the residue tested in a radiant matter tube. The spectrum was bright, the citron band, the two green bands, the blue, and the red bands showed distinctly.

81. A mixture was now prepared in the proportion of 1 of yttrium to 500 of calcium, and tested as above. The citron band was strong, but the green bands were fainter; the blue bands were still visible.

82. A mixture containing 1 of yttrium to 1000 of calcium was next prepared. In the radiant matter tube the citron band was almost as strong as in the last experiment, but the edges were not so sharp, the blue bands were faint, and the green bands had disappeared.

83. A mixture containing one of yttrium to 5000 of calcium tested in the radiant matter tube showed the citron band still very bright, but hazy about the edges. No other bands were seen.

84. A mixture of 1 yttrium and 10,000 of calcium was now tried. The citron band was still decided, but not at all sharp.

85. One of yttrium to 100,000 of calcium was next prepared and tested. The citron band was faint, but easily seen. It could not, however, be obtained at all sharp, and appeared broader than usual.

86. A mixture of 1 of yttrium and 1,000,000 of calcium was lastly prepared, and tested in the radiant matter tube. The citron band was very faint, but there was no mistaking its presence, and with care I have no doubt a smaller quantity than 1 in 1,000,000 could be detected. This, however, appears to be near the limit of the test.

87. These seven tubes were mounted on a board, so that connection with the induction coil could rapidly be made to either of them; and various minerals, &c., were prepared and tested in radiant matter tubes (10). By comparing their spectra with those of the standard tubes I could, after a little practice, determine roughly the proportion of yttrium present, supposing the test not to be interfered with by the presence of phosphoric acid (78).

88. The following are some of the most interesting results obtained in this way:—(See Table on next page).

Indications of other Spectrum-yielding Elements.

89. Throughout the course of this paper I have devoted myself only to the citron-band spectrum. I do not, however, wish it to be thought that no other spectra were obtained. On the contrary, I have repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band, and, more rarely, of a third spectrum distinct from the other two. These I am investigating, but not yet having obtained definite results I forbear from saying any more about them. I hope that they may bear sufficiently good fruit to be worthy of presentation at some future time to the Royal Society.

		Parts.
Pink coral (one partiticular specimen)	One part of yttrium in	200
Strontianite	One ,, ,,	500
Stilbite	One ,, ,,	500
Hydrodolomite, from Vesuvius	One ,, ,,	500
Witherite	One ,, ,,	1000
Arragonite	One ,, ,,	2000
Chrondrodite (Humite), from Vesuvius	One ,, ,,	4000
Egyptian syenite (Cleopatra's Needle)	One ,, ,,	7000
Calcite	One ,, ,,	10,000
Natrolite	One ,, ,,	10,000
Ox bone	One ,, ,,	10,000
Meionite (Vesuvius)	One ,, ,,	10,000
Meteorite (Alfianello, Feb. 16, 1883)	One ,, ,,	100,000
Brevicite	One ,, ,,	200,000
Prehnite	One ,, ,,	500,000
Thomsonite	One ,, ,,	500,000
Vesbine, mixed with lava, from Vesuvius	One ,, ,,	700,000
Dolomite	One ,, ,,	1,000,000
Tobacco ash	One ,, ,,	1,000,000
Leucite, from Vesuvius	Less than one ,,	1,000,000
Nepheline, from Vesuvius	None	
Meteorite (Dhurmsala, 1860)	None	
Analcite	None	
Phenakite	None	
Chrysolite	None	
Haüynite	None	
Turquoise	None	

ON THE DETERMINATION OF PHOSPHORUS IN IRON AND IRON ORES.

By ADOLF TAMM, Ph.D.

In 1859 Prof. Eggertz communicated to the *Jernkontorets Annaler* his accurate and complete enquiry into the quantitative estimation of phosphorus by weighing the precipitate obtained on the addition of an ammoniacal molybdate solution to a phosphoric acid solution. This process has ever since formed the basis of the molybdate method used for the estimation of phosphorus in iron and iron ores. Many chemists prefer to precipitate phosphoric acid by means of a magnesia solution, and weigh the magnesic pyrophosphate, usually after precipitating by the molybdic solution, but sometimes without such previous precipitation. After many years' experience in the chemical analyses of iron and iron ores, &c., I have not yet found any reason to depart from Eggertz's simple molybdate method. Comparative experiments always gave the same result as the magnesia method, pre-supposing that each method was executed by observing the same necessary care.

Phosphorus Determination in Iron.

I pointed out in the *Jernkontorets Annaler*, 1883, p. 74, that certain measures of precaution must be observed in regard to the method of dissolving the iron, if the phosphorus shall be obtained completely precipitable by means of the molybdic solution; but these precautions are alike necessary whether the molybdate precipitate be weighed direct, or again dissolved for determination as magnesic pyrophosphate.

In order to test the results of phosphorus determinations in iron by several different methods, also performed by other chemists, I obtained the assistance of E. Bergman and E. Trotz. In all 67 analyses were made upon nine different samples, embracing cast-iron with varying amounts of phosphorus, iron wire, and cast steel. Four methods of solution of these were tested against each other. Then the various methods of precipitation and weighing were tested, such as the molybdate method, in which the molybdate precipitate was weighed direct; the molybdate magnesia method in which precipitation by ammonium molybdate preceded precipitation by the magnesia mixture; and lastly an acetate of magnesia method, in which by means of acetate of soda the phosphoric acid is precipitated in combination with ferric oxide, to be afterwards dissolved, precipitated, and weighed as magnesic pyrophosphate.

For *the solution* of the iron, and its further treatment before precipitation with ammonium molybdate, several different methods have been tested by me, of which the following, A, B, C, and D, may be cited as employed in this investigation:—

In method A the iron is dissolved in nitric acid of 1·20 sp. gr., and for every gramme of iron use 12 c.c. The solution is made by boiling upon a hot iron plate, or gas flame; boil briskly till dry, heat the dried iron salt for an hour at the melting-point of tin or about 200°. Then dissolve in hydrochloric acid of 1·19 sp. gr.; use for each grm. iron about 6 c.c. The solution is again boiled quickly till dry, then again dissolved with hydrochloric acid in the same way, evaporate the excess acid as much as possible without drying any portion of the iron salt. Water is now added to one or two times the volume of the solution, about 5 c.c., and the silica filtered off.

I have found the strong drying of the nitric acid solution, *without the previous addition of hydrochloric acid*, to be the surest means of obtaining the phosphorus completely precipitable with ammonium molybdate. The second drying is, on the other hand, not necessary for the complete extraction of the phosphorus, but because it requires little time, and the silica is thereby made easier to filter off, and according to my experience in most cases saving time.

This method of solution, which I recommended as the most certain in my paper last year, has also in the series of analyses performed by Bergman and Trotz given the highest and the most trustworthy results.

In method B the iron is dissolved in nitric acid, evaporated to dryness, re-dissolved in a mixture of 3 c.c. hydrochloric acid and 2 c.c. nitric acid, diluted with 4 c.c. water for each grm. of iron, then filtered from the silica.

In many comparative trials I have for several years found that this method of solution gave the same results as by solution in nitric acid, without pushing the evaporation to dryness but only to half its volume, then dilute with water and filter.

In both of these methods the precipitation with ammonium-molybdate gave only two-thirds to three-fourths of the amount of phosphorus. In many comparative tests I made by this method, most of the results were alike low when the molybdate precipitate was weighed as such, or,

when precipitated with the magnesia solution. The loss by this method does not depend upon incomplete solution of the iron, for in those found low I have fused the silica in soda, separated the silica by the usual method, and on the addition of ammonium molybdate no phosphorus precipitate was obtained.

In method C the iron is dissolved in nitric acid as in A, boiled till the solution thickens, hydrochloric acid of 1·19 sp. gr. is added (6 c.c. for each grm. of iron), the boiling continued till dry, and heated for an hour to at least 200°, dissolved in hydrochloric acid, and excess evaporated, diluted, and filtered from the silica.

This method with ammonium-molybdate has certainly sometimes yielded the same result as by A, but often lower, even to a tenth part less than those obtained by A. To obtain phosphoric acid by C method completely precipitable by ammonium molybdate I have found it necessary after drying to heat to about 300°; but this temperature is difficult to obtain on an iron plate—it injures the glass vessels, and solution according to A is preferable.

Some chemists dissolve the iron in aqua-regia, or add hydrochloric acid immediately after nitric acid without previous boiling, but I have found that the danger of obtaining yet lower results is greater than according to the method C, although the difference in small amounts of phosphorus is certainly not noticeable.

In method D the solution of the iron is made as in C, with this difference, that, after the addition of hydrochloric acid, the boiling is not continued to dryness, but only as long as none of the iron salt is dried; water is then added and the silica filtered off.

This method is not recommended, because the silica clogs the filter and requires an unreasonably long time for filtration.

These results show that the strong drying according to C does not help to make the phosphoric acid more completely precipitable than only boiling with aqua-regia, without any drying, according to D. Both these methods give certainly in general too low results, but one so much higher than the method B, for a great part of the phosphoric acid according to B remains unprecipitable. This must be accepted in method D as changed to precipitable only by boiling with strong aqua-regia. Then, that phosphoric acid which, after dissolving iron in nitric acid, is unprecipitable by ammonium molybdate, but becomes precipitable through the strong drying according to method A, cannot be explained by inferring that the phosphoric acid by drying is brought into combination with oxide of iron and thereby converted into a precipitable form. Rather, the evident result of method D gives further support to the opinion expressed in my former paper on this subject—that the cause of the phosphoric acid in iron dissolved in nitric acid, being partly unprecipitable by ammonium-molybdate, is to be ascribed to the organic acids which are formed in the solution by the combined carbon. That these acids are completely destroyed when treated according to method A is seen from this: that white cast-iron, according to this method, always gives solutions and molybdate precipitates of a pure yellow colour, on the contrary, such iron, especially according to method B, but also according to C and D, gives solutions and precipitates with a more or less strong brown colour, proceeding from these acids. This opinion concerning the action of the carbon is not contradicted by the fact that the phosphoric acid can be completely precipitated in combination with ferric oxide, for then the power of the organic acid to maintain it in solution is annulled by the previous neutralisation. My view, therefore, is that we can, as a general rule, prescribe for phosphorus determination in iron; that its solution shall be treated in such a manner as that the action of the organic acids be suppressed, either by being themselves destroyed, or by neutralising and precipitating the phosphoric acid in combination with ferric oxide. The former seems to me the simplest, and can be most certainly attained by the A method of solution.

The molybdate method of precipitating and weighing phosphoric acid is usually applied by me in the following way:—

The solution filtered off from the silica is taken in a beaker which has been washed in ammonia and rinsed with pure water, but not dried with a cloth; otherwise the molybdate precipitate adheres to the bottom and sides of the beaker. To avoid much wash-water use the smallest filter, yet not so small as to unduly prolong filtration.

For 1 grm. iron the filtered solution should not exceed about 20 c.c., or for 5 grms. 50 c.c.; add a similar volume of molybdate solution.

This *solution is prepared* according to Eggertz's prescription by dissolving 100 grms. pure molybdic acid, or the corresponding amount of hydrate, in 422 c.c. ammonia of 0·95 sp. gr., and while stirring the solution add 1250 c.c. nitric acid of 1·20 sp. gr.; or by dissolving 123 grms. crystallised ammonium-molybdate in 333 c.c. ammonia of 0·95 sp. gr. and 62 c.c. water, and to the solution add 1250 c.c. nitric acid of 1·20 sp. gr.

If the amount of phosphorus in the iron is large, up to several tenths of one per cent, add more molybdate solution, so that for every 0·001 grm. phosphorus use an excess of 2 c.c. molybdate solution. Heat up the solution now for 4 hours to 40°, then syphon off the clear solution with a glass syphon having a hole blown in the side of the tube 1 c.m. above the end of the short leg introduced into the beaker, by which it is possible to remove the bulk of the solution without any of the precipitate following. That phosphoric acid is completely precipitated by this method I have tested by adding to the syphoned solution, either more molybdate solution or ammonium nitrate, and heating to 40° or higher without any weighable precipitate being obtained. Neither have higher results been obtained by addition of ammonium nitrate before the molybdate solution, nor by (Troilius's method) addition of hydrochloric acid before completely drying, and then evaporate until dry, and all red fumes have ceased.

The precipitate is taken upon a filter of not more than 2 inches diameter, which has been dried at 120° and carefully weighed. In performing many analyses it is not necessary to dry all the filters before weighing. Satisfactory results may be got by weighing filters undried, and then immediately after drying at 120° determine the moisture, and from their weight calculate the amount per cent lost by drying. It appears that the percentage of moisture in filters weighed at the same time is usually alike, and that upon various occasions filter-paper at chamber temperature commonly shows very small variations. The usual moisture amounts to 5 or 5·5 per cent of the weight of the undried paper, and for a filter of 5 centimetres diameter it seldom varies more than from about 0·0005 to the highest, 0·001 grm., but this amount of phosphorus precipitate from 1 grm. iron corresponds to not more than 0·001 to 0·002 per cent of phosphorus. When no very great accuracy is required, all drying may be neglected, and the weight of the undried filter reduced by 5 per cent of its weight.

Washing of the molybdate precipitate is done with water containing 1 per cent nitric acid of 1·20 sp. gr., by which it is not sensibly dissolved under the short time required, although it tends to dissolve under prolonged treatment with nitric acid and water. The washing may be accelerated by suction, and in the absence of other arrangements for this purpose, a very speedy washing is obtained by connecting to the end of the filter-funnel—with a short piece elastic tube—a glass tube 20 to 30 centimetres long, bent a little above the middle into a full turn. With this arrangement* the filtration and washing may be completed in 20 minutes. The washing is continued as long as an iron reaction is obtained with ferrocyanide of potassium, or till a drop evaporated leaves only a perceptible spot, and any long interruption must be avoided, because the precipitate is thereby made sensibly

* Figured in Fresenius's "Quantitative Chemical Analysis," p. 78, as Piccard's.

soluble. I have ascertained that an extra washing with the above nitric acid water does not tend to dissolve the precipitate. Two analyses of some eight phosphorus estimations of iron were treated identically; only one set was washed with double the amount of nitric acid water than the other; the results did not differ more than 0·001 per cent; five of the eight double washed being each reduced by that amount.

As soon as the washing is finished, place the funnel in an air-bath heated to 120°, and after drying remove the filter with pincers, and as soon as it feels only sensibly warm to the back of the hand place it point downwards in tared weighing tubes, or porcelain crucible, and weigh. For small amounts of phosphorus the drying is usually finished as soon as the filter appears bluish-green. The drying and weighing commonly takes about half an hour. Greater amounts of phosphorus require somewhat longer time. The precipitate dried at 120° contains 1·64 per cent phosphorus.

That this method gives most satisfactory results is shown by the agreement between the analyses made by it, and by that according to the magnesian methods when the solution is made in the same way. The method of treatment adopted in phosphorus precipitation is based in all its details upon Professor Eggertz's investigations, even in respect to the improvements which have been introduced by degrees, to obtain speedier results, as in drying at 120° instead of 100° as formerly.

If arsenic is found absent this method can be further accelerated by heating the molybdate solution to 50° before adding it to the boiling iron solution, and filtering after lapse of an hour. In this way I have in many comparative trials obtained the same results as in those made according to the above method of procedure.

Experiments prove that there is no special necessity in precipitating with molybdate solution to add ammonium nitrate, or to wash the molybdate precipitate either with ammonium nitrate or with diluted molybdate solution.

The close agreement between the results by the *acetate magnesia method* of Mr. Riley (*Journ. Chem. Soc*, March, 1878) and that obtained by the molybdate method after solution according to method A, are in general so good that the former may be regarded as evidence of the accuracy of the latter method. The molybdate method possesses the same accuracy as the magnesia method, but attained with greater speed.

If very large amounts of phosphorus (over 1 or approaching 2 per cent) are to be determined, the drying and weighing of the molybdate precipitate is admitted to be difficult, and in such cases the molybdate magnesia method after solution according to A may be preferable. Such great amounts of phosphorus in iron are so seldom met with that the weighing of the molybdate precipitate will present no difficulty. But in phosphorus determinations in superphosphates and similar substances, the weighing of the molybdate precipitate will be too difficult, and therefore precipitation with magnesia solution is necessary.

The acetate magnesia method is too tedious to recommend for practical iron analyses, but as a check in doubtful cases made by the molybdate method, it is much more preferable than the molybdate magnesia method, for the former process, from beginning to end, rests upon quite other principles than the latter, though if the iron is not correctly dissolved the results will have the same error as in the molybdate method.

Concerning the amount of phosphorus in iron, I have found that it is not always so uniformly distributed as we in general seem inclined to accept. Thus from cast-iron produced from the same materials the phosphorus varies from 0·020 per cent to 0·027 per cent, or from 0·024 per cent to 0·030 per cent. This may depend upon the variation of the amount of phosphorus in the ore as well as in the fuel; but it may also in some proportion proceed from more or less phosphorus being expelled in the blast-furnace gas or removed in the slag.

In iron or steel ingots produced by the Bessemer process, it is usual to find again the full amount of phosphorus present in the pig-iron, but in hearth refined iron the amount of phosphorus is commonly somewhat less than in the cast-iron used; at the same time a part of the phosphorus from the cast-iron is oxidised and removed in the slag. In iron made in the Lancashire hearth the phosphorus amounts to two-thirds or three-fourths of that in the cast-iron from which it is made when special care is taken to reduce the phosphorus as low as possible; but when such care is not taken the phosphorus in the iron often varies from two-thirds to the full amount of that in the cast-iron, and in some few cases a bar or two may have the amount of phosphorus exceed that in the cast-iron; this is not difficult to explain when it is remembered how easily phosphorus is sometimes reduced from the slag. This danger is thought to be less in the Walloon process than in the Lancashire hearth, and iron made in the Walloon hearth in general contains at most two-thirds down to the smallest trace of the phosphorus present in the cast-iron used. The amount of phosphorus met with in bar-iron varies not merely in the separate bars but also in different parts of the same bar.

The Determination of Phosphorus in Iron Ores.

The finely pulverised ore is commonly dissolved either in aqua-regia or in strong hydrochloric acid; the latter appears to be the most serviceable in effecting speedy solution. Special care must be taken to ascertain that the ore is digested sufficiently long with acid before proceeding to evaporate for separation of the silica. Drying at a higher temperature gives the same results as drying on the water-bath. After separation of the silica proceed in the same way as in the phosphorus determination in iron.

I have met with only one iron ore that contained phosphorus somewhat insoluble in acids. This ore—in which occurs the mineral pyrophyllite—gave on dissolving in hydrochloric acid 1·19 sp. gr. 0·242 per cent phosphorus. After fusion with soda, dissolving in aqua-regia, and separation of silica in the usual way, the ore gave 0·743 per cent phosphorus.

The most certain phosphorus estimations in iron ores are obtained by fusion with soda—2 grms. is sufficient for 1 grm. ore; dissolve in aqua-regia; separate silica in the usual way, and precipitate the phosphoric acid from the filtrate as in the process for iron.

ON THE

CHANGES WHICH TAKE PLACE IN THE CONVERSION OF HAY INTO ENSILAGE.

By FREDK. JAS. LLOYD, F.C.S.,
Lecturer on Agriculture, King's College.

THE recently published number of the *Royal Agricultural Society's Journal* contains some information upon the subject of silage which appears to me of considerable interest to those chemists who are at present investigating the changes which take place in the conversion of grass into silage. The data* are, so far as I know, unique, and though the analytical work is not my own, yet it is that of an agricultural chemist, Mr. A. Smetham, of Liverpool, whose work I know from personal experience to be thoroughly careful and reliable. I have therefore no hesitation in basing my remarks upon it.

We have here for the first time an accurate account of the quantity of grass put into a silo, of the quantity of silage taken out, and of the exact composition both of the grass and resulting silage. I desire merely to place myself in the position of, so to speak, a "chemical accountant."

* *Royal Agricultural Society's Journal*, vol. xx., Part I., pp. 175 and 380.

The ensilage has been analysed at three depths, or rather in three layers, the first being 1 foot, the second 1 ft. to 1 ft. 6 in., and the third 1 ft. 6 in. to 2 ft. from the bottom of the silo. By doubling the figures of the bottom layer analysis, adding these to the second and third layer analysis, and dividing by 4, we obtain a fair representation of the average composition of the silage taken throughout the silo, for by so doing we obtain the average of the analyses of each 6-inch layer of silage. The results of the analyses are as follows, calculated on the dry matter. The moisture was practically the same, being 70·48 per cent in the grass and 72·97 in the silage.

Composition of Grass and Silage (dried at 100° C.).

	Grass.	Ensilage.
Fat (ether extract)	2·80	5·38
Soluble albuminous compounds.	3·06	5·98
Insoluble albuminous compnds.	6·94	3·77
Mucilage, sugar and extractives, &c.	11·65	4·98
Digestible fibre	36·24	33·37
Indigestible woody fibre	32·33	31·79
	93·02	85·27
Soluble mineral matters	5·24	12·62
Insoluble mineral matters . ..	1·74	2·11
	100·00	100·00

The striking difference in the mineral matter of the grass and silage I will merely draw attention to; it is not due to the salt added to the silage. I may say, however, that other analysts and I myself have found similar striking differences. For instance, Professor Kinch* found in grass 8·50 per cent mineral matter, in silage 10·10 per cent, which, as he points out, is equivalent to a "loss of about 18 per cent of combustible constituents"—a loss which we have no proof of having taken place. In Mr. Smetham's sample the loss would have to be 50 per cent, which did not occur, and in fact is not possible. What is the explanation?

I am, however, considering now the organic constituents. Calculating the percentages of these in the grass and silage we obtain the following figures:—

Percentage Composition of Organic Compounds.

	Grass.		Ensilage.
Fat (ether extract)	3·01		6·31
Soluble albuminous compnds.	3·29	10·75 11·43	7·01
Insoluble ,, ,,	7·46		4·42
Mucilage, sugar and extrctvs.	12·52		5·84
Digestible fibre	38·96		39·14
Indigestible woody fibre . ..	34·76		37·28
	100·00		100·00

The difference in the total nitrogen in the grass and silage is equal to 0·68 per cent of albumenoids. Practically it is a matter of impossibility that the nitrogen could have increased in the silo, and it will be a very safe premise upon which to base any further calculations that the total amount of nitrogen in the silage was identical with that in the grass. There may have been a loss, but that is not yet proved. Arguing then upon the first hypothesis, it is evident that 100 parts of the organic matters of silage represent more than 100 parts of the organic matter of grass, and by the equation we obtain 10·75 : 11·43 :: 100 : 106 approximately. If now we calculate the composition of 106 parts organic matter of grass it will represent exactly the organic matter which has gone to form 100 parts of that present in silage.

The following table gives these results, and also the loss or gain in the various constituents arising from the conversion into silage.

* *Journ. Chem. Soc.*, March, 1884, p. 124.

Organic Matter.

	In 106 pts. Grass.	In 100 pts. Silage.	Loss or Gain.
Fat (ether extract)	3·19	6·31	+3·12
Soluble albuminous compnds.	3·49	7·01	+3·52
Insoluble ,, ,,	7·91	4·42	−3·49
Mucilage	13·27	5·84	−7·43
Digestible fibre.	41·30	39·14	−2·16
Indigestible woody fibre . ..	36·84	37·28	+0·44
	106·00	100·00	

These calculations show, provided my reasoning be correct, that the chief changes which take place are in the albuminous compounds, which has already been pointed out by Professors Voelcker, Kinch, and others; and in the starch, gum, mucilage, sugar, and those numerous bodies termed extractives, which was to be expected. But they show most conclusively that the "decrease in the amount of indigestible fibre and increase in digestible" so much spoken of is, so far as our present very imperfect methods of analysing these compounds permit us to judge, a myth; and I have not yet found any sufficient evidence to support this statement. A loss, then, of 6 parts of organic matter out of every 106 parts put into the silo has in this instance taken place, due chiefly to the decomposition of starch, sugar, and mucilage, &c. And as the grass contained 70 parts of water when put into the silo, the total loss would only be 1·7 per cent of the total weight. This theoretical deduction was found by practical experience correct, for Mr. Smith, agent to Lord Egerton, upon whose estate this silage was made, in his report to Mr. Jenkins, says the "actual weight out of the silo corresponds exactly with the weight we put into the same."

In my judgment these figures are of interest to the agricultural chemist for many reasons. Firstly, they will clear the ground for future workers and eliminate from their researches what would have greatly complicated them—changes in the cellulose bodies.

Secondly, they are of interest because our present methods of distinguishing between and estimating digestible and indigestible fibre is most rough, and probably inaccurate, and may not in the least represent the power of an animal—say a cow—to digest these various substances; and most of us know that when a new method of analysis becomes a necessity, a new method is generally discovered. Lastly, they are of interest to the agriculturist, for they point out, I believe for the first time, the exact amount of loss which grass—or at least one sample—has undergone in conversion into silage, and also that much of the nitrogenous matter is changed, and so far as we know at present, lost its nutritive value. This, however, is only comparing silage with grass. What is wanted is to compare silage with hay—both made out of the same grass. Then, and then only, will it be possible to sum up the relative advantages or disadvantages of the two methods of preserving grass as food for cattle.

Agricultural Laboratory,
4, Lombard Court E.C.

Society of Arts.—The last course of Cantor Lectures for the present session will be on "Fermentation and Distillation," by Prof. Noel Hartley, F.C.S. The course will consist of three lectures and will be given on Monday evenings, the 12th, 19th, and 26th instant.

A Case of Dimorphism observed with Sodium Hyposulphite.—F. Parmentier and L. Amat.—The authors have obtained crystals of this salt, of an unusual form, by cooling very concentrated solutions of this salt by means of a freezing mixture, in the absence of any particle of the ordinary crystal. The crystals thus produced agree in composition with the normal form, but they melt at 32° instead of at 49°.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, May 1, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—H. B. Baker, E. J. B. Barlow, W. F. Fremersderff, J. Hargreaves, F. Nettlefold, J. Parr, A. E. Page, T. Stormouth, J. S. C. Wells.

The following papers were read:—

"*On Benzoyl-acetic Acid and some of its Derivatives*" (Part I.), by W. H. PERKIN, Jun. For various reasons the author determined to carefully examine benzoyl-acetic ether with special reference to reactions in which the ketone group takes part. He describes first the preparation of phenyl-propiolic acid; 500 grms. of cinnamic acid are suspended in 1 to 1½ litres of absolute alcohol, and hydrochloric acid is passed until the whole is dissolved. After standing for 2 to 3 hours the product is poured into ice and water. The cinnamic ether separates out as an oil, which is dissolved in ether, washed with a dilute solution of sodium carbonate, and thoroughly dried and treated with 440 grms. of bromine. After standing for a short time the whole is poured into a large dish and the ether allowed to evaporate, when phenyl-dibromo-propionic ether separates out as a solid cake of large crystals. These are pressed between filter-paper and decomposed by alcoholic potash. The potassic phenyl-propiolate is finally treated with dilute sulphuric acid, when the free acid separates out as an oil. After purification it was obtained in crystals, the measurements of which are given. The acid was then converted into phenyl-propiolic ether, which, when treated with ordinary sulphuric acid slightly diluted with water, forms benzoyl-acetic ether. Full details of all the reactions are given. The ether is a colourless oil boiling 265° to 270° without much decomposition; it gives the same violet colouration with chloride of iron as aceto-acetic ether; boiled with dilute sulphuric acid it splits up into aceto-phenone, alcohol, and carbonic anhydride. The hydrogen atoms in the CH_2 group are replaceable by sodium. The barium, silver, copper, and lead salts were prepared. When pure benzoyl acetic ether is treated with dilute aqueous potash, and the resulting product decomposed with dilute sulphuric acid, benzoyl-acetic acid was obtained, which, after purification, crystallised in thin transparent needles, which polarise light and melt 103° to 104°. The copper, lead, calcium, barium, and ferric salts were prepared, and two analyses are given of the pure acid. In the next part of the paper the author has prepared compounds in which the hydrogen atoms in the methylen group are substituted by ethyl, &c. Thus, ethyl-benzoyl-acetic acid, melting at 111° to 115°, and ethyl-benzoyl-acetic ether were investigated. The latter substance, when treated with moderately dilute potash, yields much phenyl-propyl-ketone, but with strong potash mostly organic acids are formed. The latter part of the paper gives an account of the preparation of diethyl-benzoyl-acetic acid, allyl benzoyl-acetic acid, the corresponding ethers, their decomposition products, and an investigation of the action of bromine on allyl-aceto-phenone.

Dr. PERCY FRANKLAND then read a paper "*On the Composition of Coal and Cannel Gas in Relation to their Illuminating Power.*" In this paper the author gives the results of his examination, somewhat in detail, of the gas supplied to some of the more important towns of the United Kingdom. The constituents which have been individually determined are the hydrocarbons absorbed by fuming sulphuric acid, carbonic anhydride, oxygen, nitrogen, hydrogen, carbonic oxide, and marsh-gas. In all cases the carbon density of the hydrocarbons has been determined, and in many cases also the hydrogen density; the carbon and hydrogen densities together representing the average molecular formula of the hydrocarbons present. Details of the determination of these densities are given, The reputed illuminating power and the ratio of the illuminating power to the proportion of ethylene to which the heavy hydrocarbons are equivalent, are also recorded. The predominant hydrocarbon seems to be ethylene, but the quantity of this gas present is quite insufficient to account for the illuminating power of the gas. So that the denser hydrocarbons, though present in comparatively insignificant proportions, have much to do with the actual illuminating power. In comparing these analyses with similar results obtained in 1851 and 1876, it is seen that the carbon density has diminished whilst the quantity of nitrogen has increased.

Dr. ARMSTRONG said that in oil-gas much of the illuminating power was due to acetylene, crotonylene, &c., and probably in coal-gas the illuminating power was due to hydrocarbons of the acetylene series rather than to benzene. He suggested that the sulphur in coal-gas, other than hydrogen sulphide, might be due to the presence of thiophene.

The SECRETARY then read a paper on "*A New Form of Pyrometer*," by T. CARNELLY and T. BURTON. The pyrometer which the authors have used since 1881 consists essentially of a copper coil which is placed in the muffle, kiln, &c., whose temperature is to be determined. Through this coil flows a constant current of water. The temperature of the water is taken as it enters the coil and as it flows out; from the difference of these two temperatures and a table the temperature to which the coil has been exposed can be ascertained. A similar instrument has been devised by Boulier (*Bull. Soc. Chim.*, 40, 108). By means of the above instrument temperatures up to 650° C. have been determined to within 25°.

The SECRETARY then read three papers by E. DIVERS and MASACHIKA SHIMOSÉ of Tokio.

I. "*On Selenium Sulphoxide.*" The authors summarise their results as follows:—A yellow modification of selenium sulphoxide appears to exist, but has not been obtained pure. When heated, it is decomposed into selenium and sulphur trioxide; sulphur trioxide oxidises selenium sulphoxide, forming selenium dioxide and sulphur dioxide. Tellurium sulphoxide, when decomposed by water, gives tellurium and sulphuric acid, and by a secondary reaction sulphurous and tellurous acids are formed.

II. "*On the Reaction between Hydrogen Chloride and Selenium Sulphoxide.*" This reaction may be represented by the two equations—

(1) $2SeSO_3 + 2HCl = SeSO_3SeCl_2 + H_2SO_3$

(2) $\underbrace{SeSO_3SeCl_2}_{\text{Selenium Sulphoxychloride.}} + HCl = \underbrace{Se_2Cl_2}_{\text{Selenium Selenochloride.}} + SO_2HOCl$

Selenium is dissolved in fuming sulphuric acid, and hydrochloric acid gas passed into the solution, which slowly deposits drops of a deep red liquid; this is the selenium seleno-chloride. The mother-liquor contains the sulphuryl-hydroxychloride, which has not yet been isolated.

III. *On Selenium Seleno-chloride.*—The properties, physical and chemical, and an analysis of this substance are given.

Dr. W. R. HODGKINSON then read a paper "*On Fluorene* (*Part* II.)." During the fractional distillation of fluorene the author noticed the formation of an orange-red substance. It appeared probable that this body might be an oxidation product. Several kilogrms. of fluorene, melting-point 100°, were slowly distilled, and the fraction between 280° and 295° crystallised from acetic acid and re-distilled. The fraction between 285° and 290° was then passed over a mixture of lead oxide and manganese oxide (5 to 1) in a wide iron tube heated to the temperature of melting tin. A red solid thus distilled over, but the coloured substance could not be separated from the unchanged hydrocarbons by distillation. A partial separation was effected by boiling the substance twenty or thirty times with 50 per cent acetic acid, which dissolved out the fluorene. The substance thus obtained crystallised

from glacial acetic acid in rhombs, m.p. 165° to 170°, subliming with partial decomposition, and forming a dense red vapour. The body was oxidised by a solution of chromic anhydride in glacial acetic acid. Two oxidation products were obtained, one crystallising in pale yellow needles, almost insoluble in cold chloroform, melting at 278°, and the other separating in short red needles melting at 188°, both having the composition $C_{13}H_8O_2$. The author has not succeeded in isolating the red colouring substance: it appears to decompose on distillation even in a vacuum, and is equally soluble with the hydrocarbons it accompanies in the different solvents.

The Society then adjourned to May 15th.

PHYSICAL SOCIETY.

Ordinary Meeting, Saturday, April 26, 1884.

Prof. F. Guthrie, President, in the Chair.

New Members:—Mr. Chattock, Mr. Inwards.

Profs. Perry and Ayrton read a paper on the "*Indicator Diagram of a Gas-Engine*," which was intended to teach to practical engineers a method of studying gas-engine diagrams. The most recent results obtained by the use of Dowson gas were stated, and it was suggested that before long gas-engines will be employed for the propulsion of ships. A large wooden model of an Otto gas-engine enabled the operations going on during a cycle of the engine to be understood. Tables were given of the constituents of coal-gas and Dowson gas, the air required for combustion, the heat of combustion, and the specific heats, to enable the characteristic equation of the fluid used in the gas-engine to be determined. An easy method of obtaining one empirical formula to represent all the diagrams which can be obtained from an engine with different quantities of gas was described, and its results compared with observation. The effects of vibration of the indicator spring in the various parts of the diagram were discussed, as well as the effect of the last explosion; which are provided for in the empirical formula. Three practical methods of determining the rate q of gain of heat by the fluid during the forward stroke were given, and a diagram was shown in which this rate could everywhere be compared with the rate of doing work. If w is the indicated work in one cycle, it was shown that 5·64 w is the total energy of combustion of one charge, and this is expended as follows:—1·45 w is the work done in the forward stroke; 2·22 w is given to the cylinder by radiation in the forward stroke; 1·5 w is carried off though the exhaust pipe; 0·47 w is given to the cylinder as heat after exhaust valve opens. The rate at which the loss, 2·22 w, by radiation occurs at every point of the forward stroke was shown on a diagram obtained from a knowledge of the temperature at every point in the stroke, and when the ordinates of this diagram were added to the q diagram previously described—a diagram was obtained showing at every point of the stroke the rate at which combination was going on. This diagram was especially important as showing the effect of dissociation in the gas engine.

Dr. W. H. Stone exhibited a simple form of syphon mercurial barometer with metrical scale. Two millimetre scales are adjusted to slide easily side by side; the lower edge of one is brought on a level with the mercury in the shorter limb, and the other slid up and down until its lower edge coincides with the upper mercury surface. The adjustment is easily effected by an observer without stooping by the use of two right-angled glass prisms fitting on the upper and lower ends of a vertical glass-tube.

The next meeting of the Society, on May 10, will be held in the Mason College, Birmingham.

Correction.—In the "Note on the Employment of the Abel Petroleum Testing Apparatus in Tropical Climates," at p. 196, the joint author with Sir Frederick Abel was Mr. Boverton Redwood (not Kidwood).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 12, March 24, 1884.

Separations of Gallium.—Lecoq de Boisbaudran.—This paper will be inserted in full.

On a Probable Cause of Discrepancy between the Electromotive Force of Batteries and Thermochemical Data.—G. Chaperon.—The author refers to the fact that an element composed of aluminium, dilute sulphuric acid, sulphate of copper, and copper gives only 0·62 volt, whilst its theoretic electromotive force is 2·06 volts. A magnesium-platinum element in potassa, contrary to what thermic data indicate, is less energetic than a zinc-platinum element in the same liquid. Although the phenomenon known as polarisation is not generally considered as capable of modifying the electrical energy furnished by a chemical action otherwise than by the fact of the passage of the current, it seems possible that the inherent properties of the metals which concur in producing this phenomenon may also modify the static electromotive force. The author has therefore verified the phenomena of polarisation produced by the metals in question in the solutions where the electric energy which they produce presents anomalies.

On Sodium Sulphites and Bisulphites.—M. de Forcrand. Of these salts the metasulphite (anhydrous bisulphite) is the only one which is permanent in solution.

Zeitschrift für Analytische Chemie. Vol. xxii., Part 4, 1883.

Determination of Volatile Organic Compounds of Chlorine.—M. Berthelot.—The author withdraws such compounds from solution by means of a current of air and watery vapour, and conducts this mixture through a red-hot tube, or causes it to be traversed by a brisk current of electric sparks. The gases are then passed through a solution of silver nitrate when a precipitate of silver chloride is formed, if chlorine was originally present. To prevent confusion with silver cyanide or acetylenide the gases after ignition may be passed into a large quantity of water, which is boiled for some time, so that hydrocynic acid and acetylene escape.

Sauer's Method of Determining Sulphur.—W. T. Mixter.—From the Chemical News.

Determination of Sugar by Clerget's Method.—J. H. Tucker and P. Casamajor.—From the Chemical News.

Determination of Sugar by Means of Polarised Light.—E. Lebaigne.—From the *Moniteur Scientifique.*

Determination of Dextrose, Maltose, and Dextrine in Starch Sugar.—H. W. Wiley.—From the Chemical News.

Elememtary Composition and Quantitative Determination of Rice Starch.—F. Salomon.—The author is of opinion that rice and potato starch are quite alike in composition, but that the former, though entirely dissolved when heated with dilute acids, is not completely transformed into glucose, but in part into compounds which do not reduce Fehling's solution.

Determination of Tannin.—F. Simand.—This important memoir will be inserted as fully as possible.

Preparation of Soap-Solution for Water Analysis.—C. R. C. Tichborne.—From the *Analyst.*

Determination of Haidness in Water.—H. W. Langbeck.—From the Chemical News.

Examination of Milk.—L. Janke.—The results obtained by desiccation are accurate and constant without the use of sand.

Analysis of Milk.—P. Vieth and O. Hehner.—From the *Analyst*.

Detection of Alum in Bread and Flour.—A. Wynter Blyth.—From the *Analyst*.

Determination of Coke and Volatile Matter in Coal.—R. Galloway.—From the *Engineering and Mining Journal*.

Titration of Alkaline Ferrocyanides with Copper Sulphate (Hurter's method)—G. Lunge.—The results are inaccurate. It is better to mix a sample with bromine-water from a burette until it no longer turns blue with ferric chloride. A second portion is then mixed with the calculated quantity of the oxidising agent and titrated with copper sulphate until a drop gives a distinct rose colouration with solution of ferrous sulphate. This process yields, however, only 79 to 85 per cent of the values obtained by precipitation as prussian blue, conversion into sodium ferrocyanide, and titration with permagnanate. Lunge considers the method sufficiently accurate as a check on the black-ash lyes.

Iron Analysis.—The colorimetric method for the determination of manganese proposed some time ago by Pichard is applied, according to Goertz, for the daily determinations of manganese in cast-steel at the iron-works of Ohio. The process is thus described by A. Ledebur:—There are required some stand burettes, about 12 m m. in diameter, containing 30 c.c. graduated in tenths of c.c.'s, beginning from below. The author uses the same burettes as for the colorimetric carbon test; a normal solution of manganese, prepared by dissolving 0·0718 grm. crystalline permanganate in 500 c.c. water. One c.c. of this solution contains 0·00005 grm. of manganese. Of the iron or steel in question there are dissolved exactly 0·2 grm. in a flask with a mark at 100 c.c. The solution is effected by means of 10 to 15 c.c. of ordinary nitric acid with the aid of heat; the solution is let cool, distilled water is added up to the mark, and the whole is mixed by shaking. Of this solution 10 c.c. are put in a 60 c.c. beaker along with 2 c.c. nitric acid and heated to incipient boiling. The flame is withdrawn, and peroxide of lead is added in excess, well shaken, heated for a short time, and when cold the liquid is filtered through an asbestos filter into one of the burettes. The filter is washed with cold water. In a second burette there is put, according as the red colour of the solution appears lighter or darker, 1 to 4 c.c of the normal solution of manganese, which is then cautiously diluted with water until both solutions when held against a sheet of white paper display the same tone of colour. If a denotes the number of c.c. of the normal solution taken, and b the number of c.c. to which the a c.c. have to be diluted, and d the number of c.c. of the iron-solution, the proportion of magnanese in the iron solution is then $\frac{a}{b}\ d + 0{\cdot}25$ per cent. If the proportion of manganese is very small, two or three times the quantity of iron may be taken. The method is most suitable for irons which do not contain much more than 2 per cent of manganese.

Colorimetric Determination of Carbon in Steel according to the Method of Eggertz.—The reader is referred to "Wagner's Report on Chemical Technology."

Sources of Error in the Determination of Iron in Ores by the Stannous Chloride Process.—K. F. Föhr.—The principal of these are the volatilisation of ferric chlorides when the ores are dissolved in fuming hydrochloric acid; the presence of pyrolusite in many iron ores by which chlorine is liberated.

Titration of Zinc with Sodium Sulphide.—M. Schrœder.—The author recommends thallium paper as an indicator in place of lead—or cobalt paper. To prepare this paper 1 grm. thallium is dissolved in nitric acid; the excess of acid is expelled in the water-bath and the residue is dissolved in 500 c.c. water. Filter-paper is soaked in this solution. The spots produced by sodium sulphide are brown and are very easily perceptible. The following three conditions must be kept in mind:—In the zinc solution there should be a large and approximately equal proportion of ammonium chloride, a slight but also approximately equal excess of free ammonia, and the zinc solution of known value used for standardising must have the same proportion of sal-ammoniac and ammonia as the liquid to be analysed.

The Detection of Colours fixed on Tissues and fibres.—Jules Joffre.—Already inserted at length.

Valuation of Sulphocarbonates.—O. Hehner and H. S. Carpenter.—From the *Analyst*.

Detection of Cotton Oil in Olive Oil.—S. S. Bradford.—The author mixes the oil in question with a solution of basic lead acetate and lets it stand for 12 to 24 hours. If cotton oil is present it takes a red colour like fresh prepared tincture of myrrh.

Analysis of Fats.—F. Reinitzer.—Barium oleate can only be dried in a vacuum over sulphuric acid; at 100° it loses oleic acid even at the ordinary atmospheric pressure. Barium stearate can be easily dried at 100°. In preparing the ammonium salts of the fatty acids an excess of ammonia must always be present to prevent the formation of an acid salt.

On Bees'-Wax.—E. Zatzeck.—The author contests the statement of Schalfeef that Brodie's cerotic acid can be split up into several acids by fractionated precipitation with lead acetate.

The Analysis of Phosphates.—H. v. Ollech and B. Toliens.—The substance of this paper has been already inserted.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Prussian Blue.—Can any correspondent inform me what demand there is for this substance in the arts, and for what purposes it is principally used? Would a production of 20 to 40 tons per week completely swamp the market?—P. B.

The Degree of Ph.D.—Could you inform me where and how the degree of "Ph.D." is obtained? I am a student of chemistry, and as I have observed that many lecturers on chemistry have this title, I should much like to know where it is to be got.—G. F. E.

Commercial Carbonate of Ammonia.—(Reply to "Ammonia.")—See "Bloxam's Chemistry," 3rd edition, p. 121, for hydrochlorate of ammonia. Sublime a mixture of one part thereof with two parts of chalk in an earthen or iron retort, with receiver of earthenware or lead. Carbonate of ammonia distils over in the liquid form, and solidifies in the receiver.—G. A. Keyworth.

MEETINGS FOR THE WEEK

Monday, 12th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.
Tuesday, 13th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
Wednesday, 14th.—Society of Arts, 8. "Telpherage," by Professor Fleeming Jenkin.
—— Geological, 8.
—— Microscopical, 8.
Thursday, 15th.—Royal, 4.30.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
—— Chemical, 8. "On the Indices of Refraction of Organic Substances," by Dr. J. H. Gladstone. "Some Minor Researches on the Action of Ferrous Sulphate on Plant Life," by A. B. Griffiths.
Friday, 16th.—Royal Institution, 8. "The Dissolved Oxygen of Water," by Prof. Odling, at 9.
Saturday, 17th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

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SOME NEW PHENOMENA OF ELECTROLYSIS.*

By G. GORE, F.R.S., LL.D.

Whilst making a series of experiments on the "self-deposition of metals," I observed, by trying a number of different metals, that several of them received an electrolytic deposit of cadmium by contact with cadmium in various solutions of that metal much more frequently than others; I therefore made various experiments to determine whether this was due to difference of density of current or to other causes.

By means of these additional trials I found, on passing an undivided current through a series of portions of the same metallic solution, that cathodes composed of different metals of equal amounts of immersed surface, required currents of different degrees of density to cause deposits of the same metal upon them, and that the differences in some cases were considerable. Another singular circumstance was also observed, viz., that the cathode which most readily received a deposit was frequently the one composed of the same kind of metal as that which was being deposited. I am now examining these new facts.

INFLUENCE OF CHANGE OF CONDITION FROM THE LIQUID TO THE SOLID STATE ON VAPOUR-PRESSURE.†

By Prof. WILLIAM RAMSAY, Ph.D., and SYDNEY YOUNG, D.Sc., Lecturer and Demonstrator of Chemistry in University College, Bristol.

The object of this Paper is to furnish experimental proof of the theory advanced by Prof. James Thomson (*Brit. Assoc. Reports*, 1871 and 1872, and *Proc. Roy. Soc.*, vol. xxii., p. 27), that the pressure exerted by the vapour of a solid substance at a given temperature is less than that of the vapour of the substance in the liquid form at the same temperature.

This relation was specially sought for by Regnault, and, as shown by Prof. Thomson, he unwittingly furnished a proof for it in the formulæ devised by him to express the vapour-pressures of ice and of water. Regnault himself, however, from the results of numerous experiments, came to an opposite conclusion, and this conclusion is as yet generally accepted.

A graphic representation of the results obtained by us on heating camphor in a barometer-tube to temperatures ranging from about 150° to 200° shows (1) considerable irregularity about the melting-point, and (2) that a prolongation of the portion of the curve representing relation of pressure to temperature above the melting-point would intersect the portion below the melting-point.

With benzene, also, the vapour-pressures of which were determined by the method described by us in a paper shortly to appear in the *Transactions* of the Society, the solid gas curve is evidently not continuous with the liquid gas curve.

Employing the same apparatus, acetic acid was successfully cooled to temperatures far below its freezing-point without solidification, and numerous extremely concordant observations of the vapour-pressures both of the liquid and of the solid acid were obtained. These observations represented graphically form two widely-divergent curves, which intersect in the neighbourhood of the melting-point of the solid acid, 16·4°.

The barometric method was next employed; but the results, like those obtained by Regnault, were capricious. That this capriciousness was not attributable to the presence of air was proved by special experiments, and it remains unaccounted for.

Several very careful determinations of the vapour-pressures of ice and of water below the freezing-point were made. A comparative method was first employed, in which ice and water cooled below its freezing-point were simultaneously subjected to the same pressure, which could be varied at will, and the differences of temperature noted.

Another series of observations had reference to the vapour-pressures of ice alone, at temperatures ranging from 0° to −16°. The numbers obtained, when represented graphically, proved not to be identical with those calculated by means of Regnault's formulæ D and E: accepting formula D, which represents the vapour-pressures of steam in contact with water, as correct, owing to the greater number of observations and the greater range of temperature over which they extend, the ice-steam curve was re-calculated by the method given by Professor James Thomson, and it was found that our observations agreed much more closely with this curve than with that deduced from Regnault's formula E.

In the original paper, figures and diagrams illustrating these points are given.

As these substances—camphor, benzene, acetic acid, and water—are representatives of very different chemical types, it may be held to be true for all stable substances that the vapour-pressure of the solid is less than that of the liquid at the same temperature, and that the differences between these pressures are calculable from thermic data, where these are known.

In conclusion, attention is drawn to the new method of ascertaining the vapour-pressures of solids and liquids, and a full statement of the important advantages which it offers is given.

ANTISEPTIC EXPERIMENTS IN A MORTUARY VAULT.*

By C. A. CAMERON, M.D., F.R.C.S.I.,
Vice-President Institute of Chemistry of Great Britain and Ireland.

In the vaults of the ancient Church of St. Michan, Dublin, the bodies deposited become desiccated and, so to speak, mummified. The muscles present the appearance of adipocere, and the ligaments resemble old leather thongs. The vaults are situated at no great distance from the surface of the ground. They are built of limestone, and the soil beneath consists of gravel of an argillaceous limestone locally termed calp. The author did not consider that any of the asserted or assumed causes of the antiseptic properties of the vaults had been proved; but he considered that they might in part be due to their remarkable dryness and the freedom of their atmosphere from dust. He made some experiments in one of the vaults with the view of ascertaining whether or not unstable organic infusions would soon ferment in them. A large number of Tyndall's tubes were charged with an infusion of melon containing 0·84 per cent of solid matter. The infusion was sterilised by exposing them for half an hour to a temperature of 300° in a paraffin bath. The tubes were kept for a week in the laboratory, at the expiration of which time the contents of two of them had become turbid and opaque. On the seventh day, four of the tubes (all of which had been sealed by the gas blowpipe) were opened, and in the course of a week their contents had become mucilaginous. The remaining twelve tubes were next

* A Paper read before the Royal Society, May 1, 1884.
† Abstract of a Paper read before the Royal Society, April 24th, 1884.

* Abstract of a Paper read before the Academy of Medicine in Ireland, April 10, 1884.

deposited in one of the vaults of St. Michan's Church, the most elaborate precautions having been adopted to allow the atmosphere in it to be quiescent before the necks of ten of the tubes had been nipped by a highly heated pincers. The vault was kept locked for six weeks, and on the 13th August, 1879, it was entered, and the tubes removed. It was found that the contents of five of the tubes had become filled with mycelium, and that the contents of the remaining seven tubes were perfectly bright and transparent. Two of these seven tubes had remained sealed. In a few days the contents of the seven tubes, to which the air of the laboratory had now access, became so thick that they could not be poured out of the tubes. The author does not venture to draw any positive conclusion from these results, but he inclines to the opinion that the contents of the five open tubes which remained clear had not fermented, owing to the air which was in contact with them being free from dust containing ova germs, &c. In the case of the five tubes, the contents of which had become decomposed, dust had of course found its way into them. It was, however, interesting to record that for six weeks in hot weather an unstable organic liquid remained undecomposed in this vault.

THE HEAT OF HYDRATION OF SALTS.

By SPENCER UMFREVILLE PICKERING, M.A.

THE heat of hydration of an anhydrous salt is assumed (Graham, *Phil. Mag.*, 1843; Thomsen, *Journ. für Prakt. Chem.*, xviii., 5) to be given by taking the algebraic difference between the heat of solution of the anhydrous salt (A) and that of the hydrated salt (B). This difference (A−B) gives, it is true, the heat produced by the absorption of a certain number of molecules of water by the anhydrous salt, but it does not represent the energy of the chemical combination of the water with the anhydrous salt; for, in addition to the heat developed in this combination, the term A − B includes the heat evolved by the conversion of a certain amount of liquid water into solid water, Persoz's researches on specific heats having shown that the water of crystallisation of a solid hydrated salt is in the condition of solid and not liquid water.

Taking the instance of magnesium sulphate and the numbers given by Thomsen—

$MgSO_4$ +aq liberates 20280 cals.
$MgSO_4,7H_2O$+aq „ −3800 „

Whence he deduces that $MgSO_4+7H_2O=24080$ cals., whereas in reality 10010 cals. of this is due to the solidification of the $7H_2O$, leaving for the chemical action represented by $MgSO_4+7H_2O$ only 14070 cals. Similar corrections should be made in other cases.

DETERMINATION OF PHOSPHORIC ACID IN ARABLE SOILS AND ROCKS.

By M. AD. CARNOT.

THE author treats 20, 25, or sometimes even 50 grms. of earth, from the soil or subsoil, at first with dilute hydrochloric acid until effervescence has ceased, and then with aqua-regia at a boiling heat. The solution obtained is diluted and filtered. It is generally coloured yellow by ferric chloride, and contains often alumina enough for the completion of the process; however, as a rule applicable in all cases, it is recommended to add 0·2 to 0·3 grm. alumina in the form of hydrochlorate.

The greater part of the acid is neutralised with ammonia, and sodium carbonate is then added until a slight change of tint occurs in the cold liquid, which, however, should remain quite limpid. A dilute solution of sodium hyposulphite is then added, and mixed rapidly by stirring, when the liquid turns first to a violet, and then becomes colourless. At this moment there is added a solution of a mixture of sodium hyposulphite and acetate (about 5 grms. of each), and the mixture is heated to a boil, and kept at this point for a quarter of an hour. The precipitate of alumina and sulphur is filtered, and washed with boiling water, so as entirely to remove the salts of iron.

M. Chancel has long ago pointed out the possibility of separating alumina from ferric oxide by means of sodium hyposulphite. The author finds that by proceeding as above the same result may be obtained in presence of phosphates. The alumina is thrown down free from iron, and carries with it all the phosphoric acid. It appears in a form much less gelatinous than when precipitated with ammonia, and can be quickly washed with hot water.

The precipitate is dried, and ignited in a small porcelain capsule, which should be kept covered at first, to prevent as far as possible the formation of sulphuric acid during the combustion of the sulphur. The phosphoric acid is certain to be found in the tribasic state in the ignited product. It is re-dissolved in a few c.c. of nitric acid, heated so as to expel the greater part of the acid, diluted with water, filtered and received into another porcelain capsule, in which it ought to occupy a volume of about 30 c.c. There is then poured into it a solution of molybdic mixture, prepared according to known rules, and it is left for twenty-four hours at a moderate temperature. It is decanted, and washed with the same reagent, observing if the liquid, on standing for a second day, leaves any further deposit.

If the yellow phospho-molybdic deposit is very slight, it may be received at once upon a tared filter, washed with alcohol, dried, weighed, and taken as containing 3·6 per cent of phosphoric acid. But care should be taken to place by the side of the capsule a similar one containing molybdic mixture and nitric acid at the same degree of dilution, in order to prove that no deposit occurs in the same time.

If, on the other hand, the yellow deposit is considerable, it is re-dissolved in a little ammonia, precipitated with magnesia mixture, and finally weighed as magnesium pyrophosphate, containing 64 per cent of phosphoric acid.—*Comptes Rendus.*

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Boric Acid.

THE author finds only the two following methods for the simultaneous determination of gallium and boric acid. The difficulty springs from the paucity of stable compounds in which boric acid can be determined.

1. From a very acid hydrochloric solution the gallium is precipitated by a slight excess of potassium ferrocyanide. To the filtrate is added a slight excess of cuprous chloride, which forms a brown precipitate of copper ferrocyanide. This is filtered off, and washed with water acidulated with hydrochloric acid. From the clear liquid the copper is removed by means of sulphuretted hydrogen gas. The liquid is then placed in the cold, under a bell-glass over a vessel containing caustic potassa. After it has been reduced to a small volume calcium chloride is added, it is supersaturated with ammonia, and evaporated to dryness by means of a moderate heat.

The determination of the boric acid is then effected by M. Ditte's method (*Comptes Rendus*, Feb., 1875, p. 490), *i.e.*, by covering the matter with a sufficient quantity of potassium and sodium chlorides taken in equal equivalents, fusing the whole at a red heat, and causing the calcium borate to crystallise by distributing the heat in a suitable manner upon the sides of the crucible. In this manner

we may either separate a small quantity of gallium mixed with much boric acid, or a little boric acid mixed with much gallium.

The calcium borate obtained at the end of the analysis is often mixed with a little ferric oxide; it is then re-dissolved in hydrochloric acid, supersaturated with potassium and sodium carbonates (or hydroxides) in equal equivalents, and ignited. The mass, on treatment with water, deposits iron oxide, whilst the boric acid remains in the alkaline liquid. The latter, after being slightly supersaturated with hydrochloric acid, is again treated according to Ditte's method.

2. The hydrochloric solution, slightly acid, is mixed with an excess of acid, potassium, and sodium acetates in equal equivalents, and a suitable quantity of arsenious acid. A current of sulphuretted hydrogen gas precipitates arsenic sulphide, which carries down with it the gallium. Air is forced through the filtrate in order to expel the greater portion of the hydrogen sulphide, and the liquid is then supersaturated with excess of a mixture of potassium and sodium hydroxides in equal equivalents. The mass is placed in a vessel of gold, evaporated to dryness, and finally ignited with access of air. It is dissolved in water, slightly acidified with hydrochloric acid, and M. Ditte's process is applied.

This method is especially advantageous for determining small quantities of gallium mixed with large proportions of boric acid.

The author has ascertained that an aqueous, or even hydrochloric, solution of boric acid loses no appreciable trace if evaporated in a vacuum at the ordinary temperature.—*Comptes Rendus.*

NOTES ON THE VOLUMETRIC ESTIMATION OF IRON.

By R. W. ATKINSON, B.Sc. Lond., F.C.S., F.I.C.

IN my last communication I pointed out that in the volumetric estimation of iron great care has to be taken in choosing the method of standardising the solution of dichromate of potassium, without which care very considerable errors may be introduced into the analysis. In the present note I wish to make some observations upon the process of titration, presuming that the strength of the dichromate solution in terms of iron is accurately known.

A fair sample of the ore having been ground sufficiently fine to pass completely through a sieve of 120 meshes to the linear inch, part of it is dried at 100° C., and when cold portions of about 0·5 or 0·6 grm. are weighed out for analysis. Unless the balance is very rapid in its action it will be found necessary to re-dry the portions first weighed out, if accurate and concordant results are to be expected. The ore is in such a very fine state of division that it greedily absorbs moisture from the air during the operation of weighing out: this applies most forcibly to the soft red ores, like Campanil and Vena Dulce, but is also true of the harder Rubio and other brown ores. The weight of the portion being accurately known, it is transferred to a conical flask, and digested at a gentle heat on a hot plate with from 10 c.c. to 15 c.c. strong hydrochloric acid, the flask being closed with a watch-glass.

It has been asserted by K. F. Föhr (*Zeitschrift*, vol. xxii., p. 609) that ferric chloride is volatile at about 100° C., but this is contrary to all my experience of the matter. It is true that yellow drops of ferric chloride may sometimes be seen depending from the under surface of the watch-glass, but this is only the case when the solution is accompanied by a boiling of the liquid, and is doubtless due to spurting. If the digestion is carried on so as to avoid bubbling, the drops on the cover are always colourless, and no loss of iron from volatilisation need be feared.

When the ore has been completely dissolved the next step is the reduction from the ferric to the ferrous state, to effect which there are three reducing agents mainly employed,—viz., zinc, stannous chloride, and sulphurous acid in the form of one of its salts. I will deal with these in the order given.

Reduction by means of zinc is capable of giving trustworthy results, provided that pure zinc free from iron is employed; or if the zinc contains iron, provided that the amount thus introduced be allowed for. But the use of zinc is open to other objections: in the first place it dissolves only slowly, and thus unduly retards the operation, which, when a number of analyses are to be carried out, is a matter of no small moment. In the second place the titration is further retarded by the slowness with which the blue colour with potassic ferricyanide is developed in consequence of the presence of zinc chloride in the solution. And lastly, the colour towards the end of the titration becomes so faint, even when fully developed, that it is impossible to distinguish the presence of an amount of iron less than one- or two-tenths per cent of the iron contained in the ore. Consequently, although reduction by means of zinc permits the analyst to obtain uniformly concordant results without the risk of error, its action is too slow and its indications are not sufficiently delicate for the most accurate work.

But however much rapidity of work may be an object to be kept in view, there can be no doubt but that reduction by zinc is greatly to be preferred to the second method, viz., reduction by means of stannous chloride. Indeed I have no hesitation in saying that the latter method, as usually performed, is open to the grossest abuses, and ought to be prohibited by any authority which may seek to reform the present methods of analysis. I will justify these remarks presently, after I have described the usual manner of carrying out the process of reduction by this reagent.

A strongly acid solution of stannous chloride is used, often of a strength roughly corresponding with that of the potassic dichromate solution. Sometimes precautions are taken to prevent oxidation by preserving it under an atmosphere of nitrogen or carbonic acid; sometimes it is merely kept in a stoppered bottle, and portions taken out with a pipette.

The portion of ore having been dissolved in hydrochloric acid, in the conical flask, boiling water is added so as to about half-fill the flask, and the liquid is kept boiling during the addition of the stannous chloride, which is added to the boiling solution until the yellow colour of the ferric chloride has disappeared, showing that an excess of the reducing agent has been employed. In order to destroy this excess an oxidising solution is cautiously added until a drop of the liquid gives a faint red colouration when brought into contact with a solution of potassic sulphocyanide on a porcelain slab. When the operator is satisfied with the reduction, the addition of the standard dichromate solution is proceeded with in the usual manner.

It will be quite evident that the accuracy of the determination of iron in the sample is dependent upon the exactness with which the oxidising solution (potassic chlorate or dichromate) is added to destroy the excess of stannous chloride present, and that it is therefore possible to get too high or too low a result at will merely by adding too little or too much of the oxidising solution. In this way an unscrupulous chemist may produce a result which will harmonise with the interests of his client, and because this method opens the way to dishonest dealing do I justify my remark that it ought to be absolutely prohibited. But apart from cases of actual dishonesty, which no doubt are exceptional, it ought to be the determination of all those who wish to earn a reputation for accuracy to abandon a process of which it can be said that its results can be made variable at will—which can be made to give

either high results to suit the seller or low results to suit the buyer. I am far from saying that analysts consciously take advantage of this power. Most are doubtless influenced quite unconsciously—not wishing to leave any stannous chloride undestroyed, some perhaps add a little too much of the oxidising agent; others may have a weak perception of red rays, so that before they are able to see the red colour produced by contact with potassic sulphocyanide an excess of the oxidising agent has been added. In this way a permanent, unconscious bias towards low results may exist. In a similar way another chemist may be afraid of adding too much of the oxidising agent, and, as the mixture of ferrous chloride, stannous chloride, and potassic sulphocyanide oxidises very readily, he may observe a red tinge, whilst there is still an excess of stannous chloride in the solution, thus finding too high results.* In fact it is easy enough to get results which are too high or too low, but with stannous chloride as a reducing agent it is a matter of the greatest difficulty to get accurate results.

One reason why stannous chloride has become a favourite reducing agent is the rapidity with which the analysis can be made:—Starting with a tin of ore the percentage of moisture and iron in the ore can be found by this method (with the above qualification as to accuracy) in from two to three hours; but I hold that it is contrary to the best interests of a chemist to seek rapidity of work at the expense of accuracy, and I therefore strongly rccommend the abandonment of this method of reduction.

Of all methods reduction of the ferric salt by the use of a concentrated solution of ammonic bisulphite is the most accurate and trustworthy. Sodic bisulphite is sometimes used, but is not nearly so satisfactory as the ammonic salt, as it is more difficult to separate the last traces of sulphurous acid from the former than from the latter. The mode of manipulation is as follows:—The ore having been dissolved in hydrochloric acid in the conicals, the solution is diluted with acidified water and filtered into pear-shaped flasks, the filters being thoroughly washed with hot acid water. The filtered ferric chloride is next carefully neutralised with ammonia, strong at first and afterwards dilute, until a faint reddish precipitate remains permanent. Two or three drops of strong hydrochloric acid are washed round the inner neck of the flask, and as the acid flows down it spreads out, dissolving any particles of ferric hydrate which may have remained on the sides of the flask. When the solution is quite clear, and of a faint reddish colour, 5 c.c. or 6 c.c. of a strong solution of ammonic bisulphite (sp. gr. 1·06) are added, the flask shaken, and boiling water added. On shaking the flask the colour entirely disappears, and the flask is then put over a burner. A small piece of thick platinum wire is introduced to assist the boiling, and about 15 c.c. or 20 c.c. of dilute sulphuric acid (1 acid to 6 water) are added to acidify the solution and to assist in the expulsion of the excess of sulphurous acid. After the liquid is once in a state of ebullition it is kept boiling briskly for thirty minutes (less time is sufficient, but it is always well to err on the safe side), during which time nearly the required amount of dichromate is run out into the dish. At the end of the half-hour the boiled solution is added to the potassic dichromate, and the titration is carried out as usual.

By proceeding as above there is only one loophole for the introduction of error, viz., in the length of time allowed for boiling off the sulphurous acid; but if the conditions as given above are fulfilled, constant and accurate results may be relied upon. The above method has this advantage, viz., that the solution is practically one of ammonio-ferrous sulphate, a salt which is one of the most stable of all the ferrous salts. It is therefore less liable to become oxidised by exposure to the air in transferring to the basin than the acid solution of ferrous chloride obtained by the two previous modes of reduction. A further advantage lies in the fact that the end reaction with potassic ferricyanide is beautifully clear and delicate, so that there is no difficulty in distinguishing the addition of 1-20th c.c. of dichromate (strength 1 c.c. = 0·005 grm. iron), equivalent to 0·00025 grm. Fe. Numerous experiments have shown that perfectly constant results can be obtained by this method, the same percentages of iron in a given ore having been found with different standard dichromate solutions (standardised as described in my first note) after the lapse of several months. It is rarely the case that three experiments carried out simultaneously give percentages of iron differing by more than 0·05 to 0·07 per cent of the ore, but the main advantage which the method of reduction by ammonic bisulphite possesses is that results are found which are perfectly independent of any unconscious bias on the part of the operator, and I feel convinced that were this method constantly and generally used we should hear less of differences of 2 per cent and 3 per cent between two chemists' analyses of the same sample of ore. The existence of "sellers" and "buyers" chemists is a disgrace to the profession, and anything which is likely to put an end to the scandal, even in one trade, ought to be welcomed.

One other point in the volumetric estimation of iron remains to be noticed. The solution of potassic ferricyanide slowly decomposes when the bottle containing it is exposed to diffused daylight and a yellowish sediment is deposited. This change is very greatly retarded, if not entirely prevented, by protecting the solution from light by covering the bottle with an inverted tin canister. Connected with this decomposition of the ferricyanide solution is the fact, already well known, that when a mixture of that solution with one of ferric chloride is exposed to daylight reduction takes place, and the solution turns blue. But it is not so generally known how rapidly this takes place, and that if the drops of ferricyanide to which the completely oxidised iron solution has been added be allowed to remain exposed to the light (protected from dust by means of a glass plate) for ten or fifteen minutes, a distinct blue tinge will be developed. It is important to remember this, for, in titrating, the blue colour requires two or three minutes to become fully developed when the amount of ferrous salt remaining in the solution is very small, and in order to prevent the drop turning blue by reduction under the influence of daylight, it is advisable to keep the slab covered with a black cloth or with a flat tin cover. By this means it is possible so to protect the mixture from change that no blueness is perceptible after the lapse of an hour or more, provided that all the iron in the solution to be titrated has been fully oxidised.

44, Loudoun Square, Cardiff.

* If an excess of stannous chloride be added to the iron solution, and afterwards an oxidising agent in insufficient amount to completely destroy the excess, a red colour will be observed on bringing a drop of the solution into contact with a drop of potassic sulphocyanide, which colour slowly disappears. It would thus seem that the ferrous salt is first oxidised, and that the excess of stannous chloride only slowly reduces it. In this way a very serious error may be quite unconsciously introduced. To avoid this I have attempted to neutralise the effect of the excess by the addition of mercuric chloride, in which I find that I have been anticipated by Dr. F. Kessler (*Zeitschrift*, xi., 249); but in my hands this method has given results almost as unreliable as are obtained by the use of other oxidising agents, though I am not able at present to assign a reason for its imperfect action. I may be able to explain it later.

Modifications of Gmelin's Test for Biliary Colours.—Capranica recommends the use of a 5 per cent solution of bromine, of chloric and iodic acid. These reagent are applied to the colouring matters, not in an aqueous, but in an alcoholic, ethereal or chloroformic solution. As the most sensitive procedure Capranica adds solution of bromine until the green colour appears, and then hydrochloric acid. On shaking, the green colour passes entirely into the hydrochloric acid. One part of bile pigment can thus be detected in 200,000. A. A. Krehbiel mixes 4 parts of the urine of a person afflicted with jaundice with 1 part hydrochloric acid and adds a saturated solution of chloride of lime, drop by drop. The characteristic colour is produced by 3 to 6 drops.—*Zeitschrift fur Analytische Chemie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ANTIMONY.

AFTER some earlier, unsatisfactory determinations, Berzellius,† in 1826, published his final estimation of the atomic weight of antimony. He oxidised the metal by means of nitric acid, and found that 100 parts of antimony gave 124·8 of Sb_2O_4. Hence, if O=16, Sb=129·03. The value 129 remained in general acceptance till 1855, when Kessler,‡ by special volumetric methods, showed that it was certainly much too high. Kessler's results will be considered more fully further along, in connection with a later paper; for present purposes a brief statement of his earlier conclusions will suffice. Antimony, and various compounds of antimony, were oxidised partly by potassium anhydrochromate and partly by potassium chlorate; and from the amounts of oxidising agent required, the atomic weight in question was deduced :—

By oxidation of	Sb_2O_3 from 100 parts Sb ..	Sb=123·84
,,	Sb with $K_2Cr_2O_7$..	,, 123·61
,,	,, $KClO_3+K_2Cr_2O_7$ ..	,, 123·72
,,	Sb_2O_3 with ,, ,, ..	,, 123·80
,,	Sb_2O_3 with $K_2Cr_2O_7$	,, 123·58
,,	tartar emetic..	,, 119·80

The figures given are those calculated by Kessler himself. A recalculation with our newer atomic weights for O, K, Cl, Cr, S, and C, would yield slightly lower values, It will be seen that five of the estimates agree closely while one diverges widely from the others. It will be shown hereafter that the concordant values are all vitiated by constant errors, and that the exceptional figure is after all the best.

Shortly after the appearance of Kessler's first paper, Schneider‖ published some results obtained by the reduction of antimony sulphide in hydrogen. The material chosen was a very pure stibnite from Arnsberg, of which the gangue was only quartz. This was corrected for, and corrections were also applied for traces of undecomposed sulphide carried off mechanically by the gas stream, and for traces of sulphur retained by the reduced antimony. The latter sulphur was estimated as barium sulphate. From 3·2 to 10·6 grms. of material were taken in each experiment. The final corrected percentages of S in Sb_2S_3 were as follows :—

28·559
28·557
28·501
28·554
22·532
28·485
28·492
28·481

Mean 28·520 ± 0·008

Hence, if S=32, Sb=120·3.

Immediately after the appearance of Schneider's memoir, Rose§ published the result of a single analysis of antimony trichloride, previously made under his supervision by Weber. This analysis, if Cl=35·5, makes Sb=120·7, a value of no great weight, but in a measure confirmatory of that obtained by Schneider.

The next research upon the atomic weight of antimony was that of Dexter,¶ published in 1857. This chemist, having tried to determine the amount of gold precipitable by a known weight of antimony, and having obtained discordant results, finally resorted to the original method of Berzelius. Antimony, purified with extreme care, was oxidised by nitric acid, and the gain in weight was determined. From 1·5 to 3·3 grms. of metal were used in each experiment. The reduction of the weights to a vacuum standard was neglected as being superfluous. From the data obtained we get the following percentages of Sb in Sb_2O_4:—

79·268
79·272
79·255
79·266
79·253
79·271
79·264
79·260
79·286
79·274
79·232
79·395
79·379

Mean 79·283 ± 0·009

Hence, if O=16, Sb=122·46.

The determinations of Dumas* were published in 1859. This chemist sought to fix the ratio between silver and antimonious chloride, and obtained results for the atomic weight of antimony quite near to those of Dexter. The $SbCl_3$ was prepared by the action of dry chlorine upon pure antimony; it was distilled several times over antimony powder, and it seemed to be perfectly pure. Known weights of this preparation were added to solutions of tartaric acid in water, and the silver chloride was precipitated without previous removal of the antimony. Here, as Cooke has since shown, is a possible source of error, for under such circumstances the crystalline argento-antimonious tartrate may also be thrown down and contaminate the chloride of silver. But be that as it may; Dumas's weighings, reduced to a common standard, give as proportional to 100 parts of silver, the quantities of $SbCl_3$ which are stated in the third of the subjoined columns :—

1·876 grms.	$SbCl_3$=2·660 grms.	Ag.	70·526
4·336	,,	6·148	,,	70·527
5·065	,,	7·175	,,	70·592
3·475	,,	4·930	,,	70·487
3·767	,,	5·350	,,	70·411
5·910	,,	8·393	,,	70·416
4·828	,,	6·836	,,	70·626

Mean 70·512 ± 0·021

Hence, if Ag=108, and Cl=355, Sb=122.

In 1861 Kessler's second paper† relative to the atomic weight of antimony appeared. Kessler's methods were somewhat complicated, and for full details the original memoirs must be consulted. A standard solution of potassium anhydrochromate was prepared, containing 6·1466 grms. to the litre. With this, solutions containing known quantities of antimony or of antimony compounds were titrated, the end reaction being adjusted with a standard solution of ferrous chloride. In some cases the titration was preceded by the addition of a definite weight of potassium chlorate, insufficient for complete oxidation; the anhydrochromate then served to finish the reaction. The object in view was to determine the amount of oxidising agent, and therefore of oxygen, necessary for the conversion of known quantities of antimonious into antimonic compounds.

In the later paper Kessler refers to his earlier work, and shows that the values then found for antimony were all too

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 8, 1.
‡ *Ibid.*, 95, 215.
‖ *Ibid.*, 98, 293. 1856. Preliminary note in Bd. 97.
§ *Ibid.*, 98, 435. 1856.
¶ *Ibid.*, 100, 563.

* *Ann. Chim. Phys.*, (3), 55, 175.
† *Poggend. Annal.*, 113, 145.

high, except in the case of the series made with tartar emetic. That series he merely states, and subsequently ignores, evidently believing it to be unworthy of further consideration. For the remaining series he points out the sources of error. These need not be re-discussed here, as the discussion would have no value for present purposes; suffice it to say that in the series representing the oxidation of Sb_2O_3 with anhydrochromate and chlorate, the material used was found to be impure. Upon estimating the impurity and correcting for it, the earlier value for Sb = 123·80 becomes Sb = 122·36, according to Kessler's calculations.

In the paper now under consideration four series of results are given. The first represents experiments made upon a pure antimony trioxide which had been sublimed, and which consisted of shining colourless needles. This was dissolved, together with some potassium chlorate, in hydrochloric acid, and titrated with anhydrochromate solution. Six experiments were made, but Kessler rejects the first and second as untrustworthy. The data for the others are as follows:—

Sb_2O_3.	$KClO_3$.	$K_2Cr_2O_7$ sol. in c.c.
1·7888 grms.	0·4527 grm.	19·2 c.c.
1·6523 ,,	0·4506 ,,	3·9 ,,
3·2998 ,,	0·8806 ,,	16·5 ,,
1·3438 ,,	0·3492 ,,	10·2 ,,

From these figures Kessler deduces Sb = 122·16.

These data, reduced to a common standard, give the following quantities of oxygen needed to oxidise 100 parts of Sb_2O_3 to Sb_2O_5. Each cubic centimetre of the $K_2Cr_2O_7$ solution corresponds to one milligram. of O:—

10·985
10·939
10·951
10·936

Mean 10·953 ± 0·0075

In the second series of experiments pure antimony was dissolved in hydrochloric acid with the aid of an unweighed quantity of potassium chlorate. The solution, containing both antimonious and antimonic compounds, was then reduced entirely to the antimonious condition by means of stannous chloride. The excess of the latter was corrected with a strong hydrochloric acid solution of mercuric chloride, then, after diluting and filtering, a weighed quantity of potassium chlorate was added, and the titration with anhydrochromate was performed as usual. Calculated as above, the percentages of oxygen given in the last column correspond to 100 parts of antimony:—

Sb.	$KClO_3$.	$K_2Cr_2O_7$ sol. c.c.	Per cent O.
1·636 grms.	0·5000 grm.	18·3	13·088
3·0825 ,,	0·9500 ,,	30·2	13·050
4·5652 ,,	1·4106 ,,	45·5	13·098

Mean 13·979 ± 0·0096

This series gave Kessler Sb = 122·34.

The third and fourth series of experiments were made with pure antimony trichloride, $SbCl_3$, prepared by the action of mercuric chloride upon metallic antimony. This preparation, in the third series, was dissolved in hydrochloric acid, and titrated. In one experiment solid $K_2Cr_2O_7$ in weighed amount was added before titration: in the other two estimations $KClO_3$ was taken as usual. If, according to Siewert's work, we take Cr = 52·009, the percentages of oxygen in the last column correspond to 100 parts of $SbCl_3$:—

Grm. $SbCl_3$					Per cent O.
1·8576	needed	0·5967	$K_2Br_2O_7$ and	33·4 c.c. sol.	7·0338
1·9118	,,	0·3019	$KClO_3$,,	16·2 ,,	7·0321
4·1235	,,	0·6801	,, ,,	23·2 ,,	7·0222

Mean 7·0294 ± 0·0024

The fourth set of experiments was gravimetric. The solution of $SbCl_3$, mixed with tartaric acid, was first precipitated by hydrogen sulphide, in order to remove the antimony. The excess of H_2S was corrected by copper sulphate, and then the chlorine was estimated as silver chloride in the ordinary manner. 100 parts of AgCl correspond to the amounts of $SbCl_3$ given in the third column:—

1·8662 grm.	$SbCl_3$ gave	3·483 grm.	AgCl.	53·580
1·6832	,,	3·141	,,	53·588
2·7437	,,	5·1115	,,	53·677
2·6798	,,	5·0025	,,	53·569
5·047	,,	9·411	,,	53·629
3·8975	,,	7·2585	,,	53·696

Mean 53·623 ± 0·015

The volumetric series with $SbCl_3$ gave Kessler values for Sb ranging from 121·16 to 121·47. The gravimetric series, on the other hand, yielded results from Sb = 124·12 to 124·67. This discrepancy Kessler rightly attributes to the presence of oxygen in the chloride; and, ingeniously correcting for this error, he deduces from both sets combined the value of Sb = 122·37.

The several mean results for antimony agree so fairly with each other, and with the estimates obtained by Dexter and Dumas, that we cannot wonder that Kessler felt satisfied of their general correctness, and of the inaccuracy of the figures published by Schneider. Still, the old series of data obtained by the titration of tartar emetic with anhydrochromate contained no evident errors, and was not accounted for. This series,* if we reduce all of Kessler's figures to a single common standard, give a ratio between $K_2Cr_2O_7$ and $C_4H_4KSBO_7.\frac{1}{2}H_2O$. 100 parts of the former will oxidise of the latter:—

336·64
338·01
336·83
337·93
338·59
335·79

Mean 337·30 ± 0·29

From this, if $K_2Cr_2O_7 = 294·64$, Sb = 119·18.

(To be continued.)

HYDRATION OF SALTS AND OXIDES.

By C. F. CROSS.

This subject may be approached from several points of view, each with its own experimental method. Thorpe and Watts† have studied the hydration of salts in the light of the volumes occupied by the successive molecules of water of hydration; Favre and Valson‡ have determined the heat constants for the solution of salts of varying degrees of hydration, and thus endeavoured to throw light upon the mode of union of water of crystallisation; Hannay and Ramsay‖ have taken up the subject from the dynamic side, applying the time method to the observation of the dehydration of salts and oxides. Lastly, I have endeavoured§ to follow the phenomena of rehydration, by means of a special method and apparatus. I have shown that when a salt is deprived of its water of crystallisation and exposed to an atmosphere saturated with aqueous vapour, it quickly combines with water up to the original limit; that here a break occurs of greater or less duration

* *Poggend. Annal.*, 95, 217.
† *Journ. Chem. Soc.*, 37, 102.
‡ *Compt. Rendus.*, vols. 73, 74, 75.
‖ *Journ. Chem. Soc.*, 1877, 381.
§ *Ibid.*, 35, 796. Chemical News, vol. 44, pp. 101, 209; vol. 47, 239.

followed by that further combination of water which is known as deliquescence. An anhydrous salt, or a salt containing its limiting quantity of water of crystallisation, passes immediately into this phase of deliquescence, or incipient solution, and these several phenomena are continuous manifestations of the same attractive energy. The hydration of oxides, although so dissimilar in its visible results, follows a similar course: and to demonstrate more clearly these common features of resemblance I have undertaken and completed a series of parallel observations upon three substances selected as types of these various modes of rehydration, viz., $CuSO_4.H2O$, $K_2Cr_2O_7$, and $Cr_2O_3.4H_2O$.

The results are graphically represented by the accompanying curves, each of which originates at the same 0 point, corresponding to 100 pts. of substance; the ordinates therefore represent the percentage increase due to combination with water. The period over which the observations extended was from May to August, 1883; the limits of temperature observed were 16—21°.

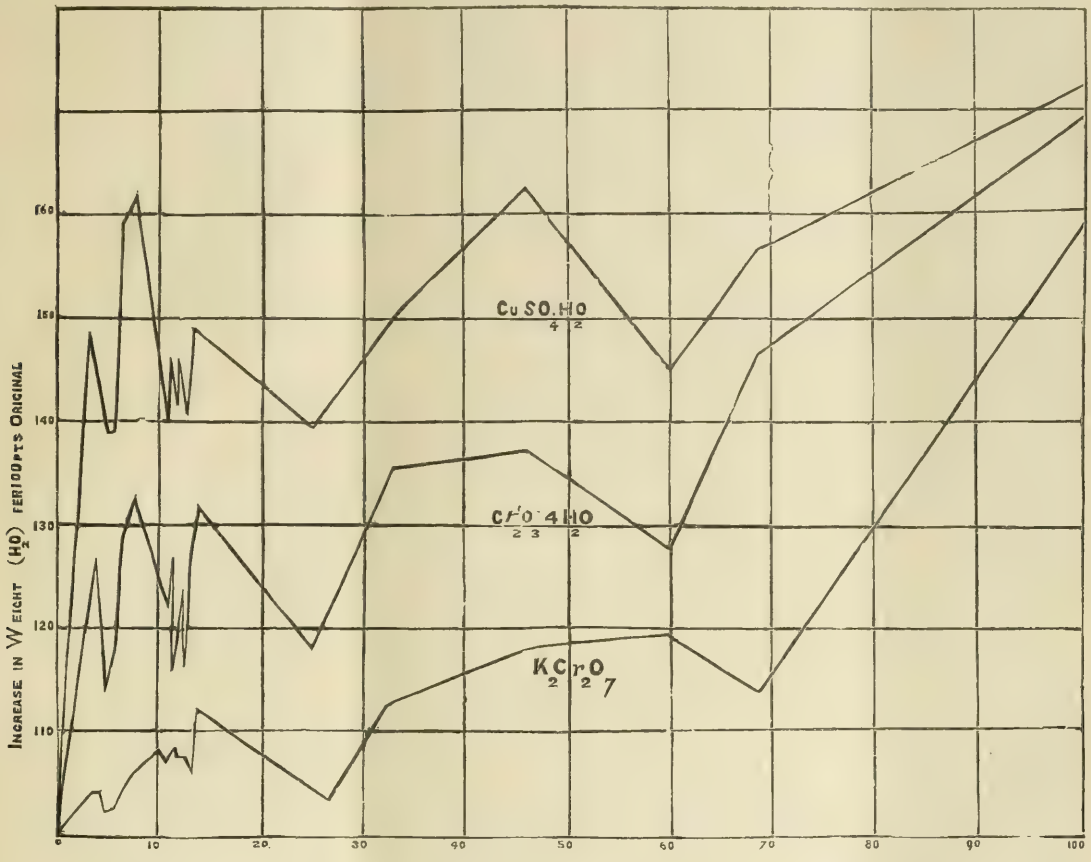
The similarity of these curves to one another in their main features is unmistakeable.

The course of hydration in the case of the copper sulphate was marked by the gradual contraction of the area of the deliquescing solid: from covering a circular area of 70 m.m. diameter at the beginning of the experiment, it occupied at the close an area equally regular and concentric with the former, but of not more than half that diameter.

The potassium dichromate presented throughout a very different appearance; the course of hydration was from the beginning rather one of liquefaction than deliquescence, the yellow solution of the salt very early making its appearance upon the scale pan.

The chromic hydrate remained throughout to all appearances a dry solid, notwithstanding that at the close of the experiment it contained 60 per cent water and had taken up nearly as much water as the copper sulphate.

In a future communication it is my intention to discuss these and previous results, together with the collateral researches of other observers, mentioned at the beginning of this paper, in their bearings on the subject of hydration.



PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, May 1st, 1884.

The Duke of Northumberland, D.C.L., LL.D., President, in the Chair.

The Annual Report of the Committee of Visitors for the year 1883, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The Real and Funded Property now amounts to above £85,400, entirely derived from the Contributions and Donations of the Members.

Thirty-seven new Members paid their admission fees in 1883.

Sixty-three lectures and nineteen evening discourses were delivered in 1883.

The books and pamphlets presented in 1883 amounted

to about 236 volumes, making, with 558 volumes (including periodicals bound) purchased by the managers, a total of 794 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year :—

President.—The Duke of Northumberland, D.C.L., LL.D.

Treasurer.—George Busk, Esq., F.R.S.

Secretary.—Sir William Bowman, Bart., LL.D., F.R.S.

Managers.—George Berkley, Esq., M.I.C.E.; Sir Frederick J. Bramwell, F.R.S.; Joseph Brown, Esq., Q.C.; Warren De La Rue, Esq., M.A., D.C.L., F.R.S.; Captain Douglas Galton, C.B., D.C.L., F.R.S.; Colonel James Augustus Grant, C.B., C.S.I., F.R.S.; The Hon. Sir Wm. Robt. Grove, M.A., D.C.L., LL.D., F.R.S.; Right Hon. The Lord Claud Hamilton, J.P.; Sir John Hawkshaw, F.R.S., F.G.S.; Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S.; Hugo W. Müller, Esq., Ph.D., F.R.S.; Sir Frederick Pollock, Bart., M.A.; John Rae, M.D., LL.D., F.R.S.; The Earl of Rosse, D.C.L., LLD., F.R.S.; The Hon. Rollo Russell, F.M.S.

Visitors.—John Birkett, Esq., F.L.S., F.R.C.S.; Charles James Busk, Esq.; Stephen Busk, Esq.; George Frederick Chambers, Esq., F.R.A.S.; William Crookes, Esq., F.R.S.; Rear-Admiral Herbert P. De Kantzow, R.N.; William Henry Domville, Esq.; Alexander John Ellis, Esq., B.A., F.S.A., F.R.S.; Rev. John Macnaught, M.A.; Robert James Mann, M.D., F.R.C.S.; Sir Thomas Pycroft, M.A., K.C.S.I.; Lachlan Mackintosh Rate, Esq., M.A.; John Bell Sedgwick, Esq., F.R.G.S.; Basil Woodd, Smith, Esq., F.R.A.S.; Charles Meymott Tidy, Esq., M.B., F.C.S.

OBITUARY.

DR. ROBERT ANGUS SMITH, F.R.S., F.C.S., &c.

THE announcement of the death of one of the oldest, most conscientious, and zealous workers in the field of Chemistry will be received by our readers and by a wide scientific circle with much sorrow. After an illness extending over several months, and indeed having been in a poor state of health for the last few years, Dr. Smith expired on the 11th inst., at Colwyn Bay, near Llandudno.

Dr. Smith was born near Glasgow in 1817, and educated first at the Grammar School, and afterwards at the University of that city. His aptitude, which early showed itself, for classical studies induced his parents to regard the Scotch Kirk as a suitable profession for their son, but his early experiences of the arbitrary dogmatism of this religious sect proved such a profession to be incompatible with his opinions, and he, like many others for the same reason, sought other more consistent channels into which to direct his energy. After spending several years as private tutor in Scotland, and ultimately in London, Dr. Smith went, in 1839, to the University of Giessen, to study Science: here he had as companions and fellow-workers men many of whom have become well known by their scientific investigations. Returning to England in 1841, he became assistant to Dr. Lyon Playfair, who was at that time engaged on a sanitary commission, and it was the investigations connected with this occupation that formed the starting-point of Dr. Smith's subsequent work on sanitary matters which are especially linked with his name.

His first paper appeared in 1846, in the *Journal of the Chemical Society*. Two years later he read a highly important paper at the Meeting of the British Association at Swansea, "On the Air and Water of Towns," several of the conclusions which he arrived at being remarkably interesting with regard to the presence of putrescible organic matter in the air of crowded rooms, and the existence of nitrates in well-waters in the vicinity of houses and towns, indicating previous pollution of the water by sewage or other animal matter. These papers were followed by two others,—"On the Air of Towns," and "On the Air and Rain of Manchester,"—both of much sanitary value.

As a tribute to the memory of Dalton Dr. Smith compiled, in 1854, a valuable History of the Atomic Theory and Memoir of Dalton, a work which, although now out of print for many years, was of considerable importance, due to the author's analyses of Richter's and Wenzel's claims to the discovery of the law of reciprocal decomposition.

Between the years 1855 and 1863 Dr. Smith contributed several papers to the Chemical Society, the Society of Arts, and the Philosophical Society of Manchester, "On Sewage and Sewage Rivers," "Disinfectants," "On the Composition of Rosolic Acid," and "On Putrefaction in Blood," some of his conclusions and experimental results being of much value from a sanitary point of view. In 1863 he was appointed Inspector-General of Alkali Works, and for this post probably a not more fit person could have been selected, as the work connected with it was essentially of that character to which he had devoted many years of experimental research. His "Report on the Air of Mines and Confined Places," which formed an Appendix to the "Report of the Royal Mines Commission, was published in 1864, and contained many valuable facts relating to ventilation, and such like; and his annual "Reports under the Alkali Act" form important contributions to sanitary science, as well as his papers "On some Physiological Effects of Carbonic Acid and Ventilation," and "On the Composition of the Atmosphere."

In 1869 Dr. Smith published his work on "Disinfectants and Disinfection," being for the most part a collection of his contributions to the various journals on this subject, and his "Report to the Cattle Plague Commission." Three years later his work on "Air and Rain" was published; and in 1876 Dr. Smith, in conjunction with the late Mr. J. Young, F.R.S., collected and printed in one large volume, for presentation only, the "Chemical and Physical Researches of Graham"; and in 1883, to commemorate the centenary of the Manchester Philosophical Society, he wrote a long and very interesting history of this Society, with biographical sketches of many of its most notable members. In addition to these more important contributions to Science, Dr. Smith has published many papers of minor interest, as "On the Absorption of Gases by Charcoal," "Some Invisible Agents of Health and Disease," "On the Measurement of the Actinism of the Sun's Rays and of Daylight," as well as several Essays and works of antiquarian interest; one of the last being a volume entitled "Loch Etive and the Sons of Uisnach," which was published anonymously. He was for many years a contributor to the CHEMICAL NEWS, most of his Reviews and Essays in these pages being, however, unsigned.

Dr. Smith was elected a Fellow of the Royal Society in 1857; he was a Corresponding Member of the Royal Bavarian Academy, Vice-President of the Chemical Society, of the Literary and Philosophical Society of Manchester, and of the Institute of Chemistry. He assisted in the Jury of the Exhibition of 1862 and of the French Exposition in 1878. In 1882 the degree of LL.D. was conferred upon him by the University of Edinburgh.

PROFESSOR WURTZ.

LITTLE did we think when reading the eloquent *eloge* pronounced by Professor Wurtz at the tomb of J. B. Dumas how soon the speaker was to follow his illustrious colleague to the silent land.

C. A. Wurtz was born at Strassburg on November 16,

1817, being thus of the same age as Dr. R. Angus Smith, whose death coincides so closely with his own.

We first hear of Wurtz as assistant in the laboratory of Dumas, who became his firm friend. His first official appointment was the Professorship of Chemistry at the Agricultural Institute of Versailles. Since 1858 he has filled the Chair of Chemistry at the Faculty of Medicine, at Paris, and has latterly been, in addition, Professor of Chemistry at the Sorbonne.

The life of the late distinguished *savant* presents little of outward interest, but it is singularly rich in important and successful research. He may justly rank as one of the founders of modern organic chemistry. For many years he has been one of the most active members of the Academy of Sciences, where his death, following so closely upon that of Dumas, will leave a painful void, and must, if we may use the expression, derange the balance of power in that learned body as far as chemistry is concerned. According to the Royal Society Catalogue he had produced seventy-three memoirs up to the year 1864, and during the subsequent twenty years he has shown no disposition to rest upon his laurels. Readers of the *Comptes Rendus* will have remarked his occasional controversies with Prof. Berthelot on points of chemical theory, and especially with reference to the question between atoms or equivalents. In these discussions Wurtz generally appears to have had the advantage.

His earliest published investigation, which dates back as far as 1842, was on the constitution of the hypophosphites. He next studied phosphorus and sulphophosphoric acid, and threw a new light on the compounds of phosphorus. One of his earlier discoveries was that of copper hydride, a remarkable, and it may be said in many respects exceptional, compound. Wurtz noted in particular that this hydride is quickly dissolved by strong hydrochloric acid, which is without action upon free metallic copper.

He next turned his attention to the cyanic and cyanuric ethers, and in 1849 he discovered the compound ammonias formed when an atom of hydrogen in ammonia is replaced by an organic radicle, such as ethyl or methyl.

His next research bore upon the discussion between Frankland and Kolbe on the one hand, and Laurent, Gerhardt, and Hofmann on the other, as to whether the radicles isolated from alcohols remained free (as maintained by the former two chemists) or combined with themselves (as shown by the latter.) Wurtz succeeded in producing decisive evidence of the correctness of the latter view. He found, on treating a mixture of the iodides of two different radicles with sodium, that a hydrocarbon was obtained, formed by the union of the two different radicles.

His subsequent researches have been too numerous to mention, and, indeed, any recapitulation of their subjects and their results is the less necessary as they have been duly noticed in the Chemical News at the time of their appearance.

Professor Wurtz was a Fellow of the Royal Society, and on November 12th, 1878, the Fellows of the Chemical Society had the pleasure of hearing him deliver the Faraday Lecture for that year.

NOTICES OF BOOKS.

Gas Works Statistics, 1884: compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

We have here, arranged in parallel columns, the tons of coal carbonised, the annual make and sale of gas in thousands, the price per thousand, the number of consumers, the price paid for public lamps, their number, the average price received for coke, the tons of ammonium sulphate made, and—most important feature of all in the eyes of shareholders—the dividend.

It will be noted that between the volume of gas made and the volume sold there is often a wide difference, amounting, in one case, to one-fourth of the entire production! The question at once arises, what becomes of the remainder? Does it escape, tainting the air and the soil? We should recommend those concerned to look closely to the condition of their mains. There is, on the other hand, one case at least where the quantity sold *exceeds* the quantity made. Whether we have here proof of the introduction of air or of defective bookkeeping we cannot presume to say.

There is no mention of the quality of coal consumed in each case, nor of the quantity of coal-tar produced and its especial properties. Information of this kind would be very useful, as the tars made from different classes of coal vary widely in the proportions of their constituents, and consequently in the purposes for which they are best adapted.

In quality and price gas varies greatly. Leeds supplies a 20-candle gas at 1s. 10d. per thousand, subject to 2½ per cent discount. On the other hand, some dozen towns charge 7s., 7s. 6d., or upwards, and, as a rule, modestly omit to give any return of its illuminating power. Two only of this class confess that their gas is of the exceedingly low power of 12-candles. These are the only two instances of such a poor quality recorded. The richest gas mentioned is that of Berwick-upon-Tweed, which is of 30-candle power.

Water-Works Statistics, 1884: compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

In this useful compilation we find an alphabetical list of the towns in the United Kingdom, with the sources of their water supply, the yearly quantity of water furnished, the method of changing the nature of the service whether constant or intermittent, and the dividend paid in cases where the works are not the property of the municipality. These dividends fluctuate greatly, but are, as a whole, very high for undertakings where the demand is constant. Ten per cent is a very frequent figure; the London New River Company rejoices in 12½, and the Basingstoke Company in 20! We notice only three cases of an intermittent supply where the water-works belong to the municipality—Shrewsbury, Swindon, and Tunbridge Wells. The evils of the intermittent system are glaring. It necessitates the cistern, which serves as a gathering-ground for pollution of varied kinds, and which, in most houses, is the point open to the attacks of frost. That the Companies, in the long run, gain anything by the intermittent system is at least questionable, if we consider the pay of the turncocks and the waste of water when it remains turned on after the cistern is full—the ball-cock not unfrequently refusing to act.

No information is given as to the quality of the different water supplies. We should suggest that a classification of the waters into hard or soft would be more generally useful than the information given as to whether the supply is obtained by pumping or by gravitation. Such a tabular view would throw considerable light on the question whether hard or soft waters are dietetically preferable.

The supply of water by meter, instead of by a percentage on the rental or rateable value, seems extending,—a movement in the right direction.

The Gas and Water Companies' Directory, 1884. Edited by Charles W. Hastings. London: Scientific Publishing Company, Limited.

This Directory embodies some features different from those which we find in the "Gas Works Statistics" and "Water

Works Statistics" by the same author. It gives the date of formation; the special Act, if any; the total share capital paid up; the dividends; the total loan capital issued; name of chairman, engineer, or manager, lessee, owner, or corporation; the population of the town or village, its distance from London, and the railway by which it is accessible. As far as we are able to judge, the information given is accurate, and the work will be useful to shareholders and to persons doing business with the various companies. Technological and sanitary features are, of course, wanting.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 13, March 31, 1884.

The Specific Heat of the Gaseous Elements at very High Temperatures.—MM. Berthelot and Vielle. At about 4500° the elementary specific heat of the following simple gases is increased threefold: hydrogen, nitrogen, oxygen. Chlorine, bromine, and iodine have molecular specific weights decidedly higher than those of the other elements, and not differing greatly from the specific heats of the compound gases formed with the contraction of one-third, such as watery vapour, nitrogen protoxide, and carbonic anhydride. At 1800° the mean specific heat of chlorine is about three times that of hydrogen.

Origin of Lactose.—Paul Bert.—This compound is produced by the excretion of the excess of sugar formed by the organism after parturition. It is probably produced in the liver.

Separation of Gallium from Organic Matter.—Lecoq de Boisbaudran.—The author gives two processes for the simultaneous determination of gallium and tartaric acid, which he considers available in presence of most other organic matters. (1) The gallium is precipitated with a slight excess of potassium ferrocyanide in a very acid hydrochloric solution. To the filtrate is added copper chloride, which throws down copper ferrocyanide. This is filtered off, and the filtrate is treated with a current of sulphuretted hydrogen, which removes the copper as a sulphide. The filtrate placed in a vacuum over caustic potassa is reduced to a small volume, and contains merely tartaric acid, potassium chloride, a little hydrochloric acid, and traces of iron, which are removed by well-known methods.—(2) The solution, slightly acid, is mixed with an excess of acid ammonium acetate and a certain quantity of arsenious acid, and is then treated with sulphuretted hydrogen. The arsenic sulphide carries down the gallium, whilst the tartaric acid remains in the liquid, and is separated from the ammonia and acetic acid by the usual methods. If it is merely intended to determine the gallium the substance may be ignited, and the ash melted with acid potassium sulphate. Chlorides must not be present, as they would cause the volatilisation of a part of the gallium.

Modification in the Earth Conductors of Lightning-Rods.—A. Callaud.—The author coats every wire of the cable with hemp saturated with ceruse or with red lead.

Transportation of the Ions, and its Relation to the Conductivity of Saline Solutions.—E. Bouty.—The electrolyses become more and more normal as the solutions employed are more dilute.

Measure of the Dissociation-Tension of Mercury Iodide.—L. Troost.—At a pressure of 750 m.m. the dissociation-tension of the vapour of mercury iodide is about 150 m.m. This tension corresponds to the fraction of mercury iodide which has been decomposed, and which is about one-fifth.

Resistance of the Carbons employed in Electric Lighthouses.—F. Lucas.—This paper is not adapted for useful abstraction.

General Theory of Dissociation.—M. Isambert.—A mathematical paper which cannot be usefully abridged.

Phenomenon of the Crystalline Superheating of Sulphur.—D. Gernez.—Not suitable for abridgment.

Non-Existence of Ammonium Hydrate.—D. Tommasi.—The combination-heat of ammonium hydrate, so-called, as calculated and as found experimentally, are respectively 54·2 and 21. Hence the author infers that the constitution of an ammoniacal solution is different from that of the alkaline hydrates.

Decomposition by Water of the Compounds of Cuprous Chloride with Potassium Chloride and Hydrochloric Acid.—H. Le Chatelier.—The author gives his results in the form of tables.

Composition of Pitch-blende.—M. Blomstrand.—Pitch-blende is a mixture of uranine, silicates, calcium carbonate, and iron sulphide. Uranine itself contains $U_7Pb(O_6U)_5$.

Determination of Phosphoric Acid in Arable Soils.—G. Lechartier.—The author criticises the process of M. Gasparin. He finds that if the sample is treated, as the latter chemist proposes, with aqua-regia, the solution precipitated with ammonia, the precipitate dried, and strongly ignited, nitric acid at one-fiftieth in the cold does not dissolve out the whole of the phosphoric acid. M. Lechartier modifies the process by precipitating with pure milk of lime in place of ammonia. The precipitate, after drying and ignition, is finely powdered, and digested at 50° to 60° with nitric acid at one-tenth. In this manner the whole of the phosphoric acid is dissolved out along with a little ferric oxide, and is then determined by the molybdic method. The solution must be suitably diluted, and must contain an excess of nitric acid. After an excess of the molybdenum mixture has been added, the liquid is quickly heated to near 100°. Until it is quite clear it is kept at a gentle heat for two or three hours, preventing loss by evaporation. If, in spite of these precautions, a yellowish residue appears after dissolving the precipitate in ammonia, it must be re-dissolved in a little nitric acid and re-precipitated with molybdenum mixture.

Formation-Heat of Silver, Magnesium, and Lead Fluorides.—M. Guntz.

Thermo-Chemical Study of Hydro-fluosilicic Acid.—Ch. Truchot.

On Sodium Glyoxal-bisulphite.—M. de Forcrand.—These three thermo-chemical papers do not admit of useful abstraction.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 4, 1883.

Determination of Humus in Arable Soils.—G. Loges.—In moor soils and in mixtures of moor and sand the determination of humus as loss on ignition is trustworthy. The method is useless in case of heavy clays and marsh-soils.

Determination of Potassa in Manures.—E. Dreyfuss.—Noticed under *Bulletin Soc. Chimique.*

Analysis of Extract of Malt.—W. Klinkenberg.

Analysis of Liquorice Juice.—C. L. Diehl.—These papers do not admit of useful abridgment.

A New Xanthinoid Compound in Human Urine.—G. Salomon.—The new compound, paraxanthine, is distinguished from the other xanthine compounds by its crystalline character. It contains nitrogen, fuses at 270°, burns at higher temperatures without residue, dissolves readily in hot water, forming a neutral solution. It does

not, like guanine, xanthine, and hypoxanthine, dissolve in caustic soda, but is precipitated thereby from its concentrated aqueous solution in microscopic retangular tables.

A Sensitive Reaction for Kynuric Acid.—M. Jaffé.—If this acid is mixed in a porcelain capsule with hydrochloric acid and potassium chlorate and evaporated to dryness on the water-bath, there remains a reddish residue, which, if moistened with ammonia, becomes brownish-green, and in a short time emerald-green. On the application of heat the colour changes to a dirty violet. Other constituents of normal urine do not produce this reaction.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

The Degree of Ph.D.—(Reply to G. F. E.)—This degree of Doctor of Philosophy is obtainable at any German University after residence of about three years: a non-German may sometimes obtain it in two years. Candidates must pass in three subjects. The degree is about equivalent in Germany to B.A. in England, but is not quite equal in England to B.A. or M.A. probably. I am not aware that French or American Universities grant this degree, but it is possible. The degree is a convenient one.—G. A. KEYWORTH.

MEETINGS FOR THE WEEK

MONDAY, 19th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.

TUESDAY, 20th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
—— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.

WEDNESDAY, 21st.—Society of Arts, 8. "Telegraph Tariffs," by Lieut.-Col. C. E. Webber, R.E., C.B.
—— Meteorological, 7.
—— Pharmaceutical, 11 a.m. (Anniversary).

THURSDAY, 22nd.—Philosophical Club, 6.30.
—— Society of Arts, 8. "Economic Applications of Seaweed," by Edward C. Stanford.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.

FRIDAY, 23rd.—Royal Institution, 8. "Distances of Fixed Stars, &c." by Mr. D. Gill, at 9.
—— Quekett Microscopical Club, 8.

SATURDAY, 24th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.
—— Physical, 3. "On an Immersion Galvanometer, and on Kohlrausch's Metre Bridges for Alternating Currents," by Dr. W. H. Stone. "On a Speed Indicator," by Mr. Walter Baily. "On Eutexia, or Lowest Temperatures of Fusion," by Dr. Guthrie.

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Forms of Tender and further particulars may be obtained on application in writing to Mr. CHARLES NICKSON, Superintendent of the Department.

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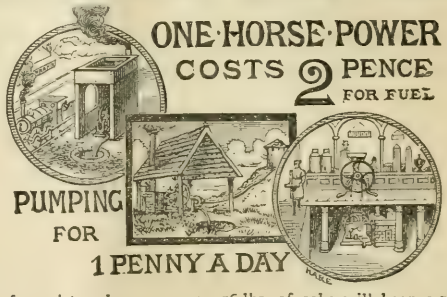

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1278.

SPECTROSCOPIC STUDIES ON GASEOUS EXPLOSIONS.*

By G. D. LIVEING, M.A., F.R.S., and JAMES DEWAR, M.A., F.R.S., Professors in the University of Cambridge.

Having occasion to observe the spectrum of the flash of a mixture of hydrogen and oxygen fired in a Cavendish eudiometer, we were struck by the brightness, not only of the ubiquitous yellow sodium line, but of the blue calcium line and the orange and green bands of lime, as well as of other lines which were not identified. The eudiometer being at first clean and dry, the calcium must be derived either from the glass or from some spray of the water over which the gases with which the eudiometer was filled had been confined. It seemed incredible that the momentary flash should detach and light up lime from the glass, but subsequent observations have pointed to that conclusion. Our next experiments were made on the flash of the combining gases inclosed in an iron tube, half an inch in diameter and about 3 feet long, closed at one end with a plate of quartz, held in its place by a screw-cap, and made tight by leaden washers. Two narrow brass tubes were brazed into the iron tube at right angles to the axis, one near each end, and one of these was connected with an air-pump, the other with the reservoir of gas. Into one of these brass tubes was cemented a piece of glass tube with a platinum wire fused into it, whereby the electric spark was passed to fire the gas.

The tube was placed so that its axis might be in line with the axis of the collimator of a spectroscope, and the flash observed as it travelled along the tube.

It was seen at once that more lines made their appearance in the iron tube than in the glass vessel, and one conspicuous line in the green was identified in position with the E line of the solar spectrum. Several other lines were identified with lines of iron by comparison with an electric spark between iron electrodes. There could be no doubt that the flash in an iron tube gave several of the spectral lines of iron. We supposed that this must be due to particles of oxide shaken off the iron by the explosion, and proceeded to try the effect of introducing various substances in fine powder, and compounds, such as oxalates, which would give fine powders by their decomposition in the heat of the flame. Several interesting observations were made in this way. When some lithium carbonate was introduced, not only were the red, orange, and blue lines of lithium very brilliant, but the green line hardly less so. After the lithium had once been introduced into the tube, the lithium lines continued to make their appearance even after the tube had been repeatedly washed. When the lithium had been freshly put in, the red line was observed to be much expanded, very much broader than the line given by lithium in a Bunsen burner reflected into the slit for comparison. The light was dazzling unless the slit was very narrow; and it was noticed that if the spark by which the gas was fired was at the distant end of the tube, so that the flame travelled along the tube towards the slit, there was a reversal of the red line; a fine dark line was plainly visible in the middle of the band. When the spark was at the end of the tube next the slit, no reversal was, in general, seen. Later observations showed that some other metallic lines might be reversed in this way, and photographs taken of the reversals. These observations with the eye on the reversal of the red lithium line were made with a diffraction grating, and were repeated many times. They show that there are gradations of temperature in the flame, and that the front of the advancing wave of explosion is somewhat cooler than the following part. The combination of the gases is not so instantaneous that the maximum temperature is reached at once. When some magnesia was put into the tube the continuous spectrum was very bright, but the iron lines were still brighter. No lines which could be identified as due to magnesium was observed with certainty; there was only a doubtful appearance of *b*. With sodium, potassium, and barium carbonates, only the lines usually seen when salts of those metals are introduced into a flame were noticed; but eye observations of this kind are extremely trying, on account of the suddenness of the flash and the shortness of its duration. Thallium gave the usual green line.

Subsequently we had the interior of the tube bored out so as to present a smooth bright surface of iron, and noted the iron lines which were conspicuous in the flash.

For the purpose of identification the pointer in the eyepiece was first placed on one of the strong iron lines given by the electric discharge between iron electrodes, and then, the discharge being stopped but the field sufficiently illuminated, the eye was fixed steadily on the pointer while the gas in the tube was exploded. In this way it was not difficult to see whether any given line was very bright in the flash. The lines thus identified were those having the wave-lengths (about 5455, 5446, 5403, 5396, 5371, 5327, 5269 (E), 5167 (b_4). These lines were all many times observed in the way described, and as a rule were always present in the flash. Lines with wave-lengths about 5139 and 4352 were seen, and may possibly have been due to iron, and several more lines were seen occasionally, but were not so regularly seen that they could be well identified. The lines λ 4923 and λ 4919 were specially looked for, but neither of them could be seen. A group of blue lines were noticed, and were afterwards identified by photography, a method much less trying than observations by eye. To give intensity to the photographs ten or twelve flashes were usually taken in succession without any shift of the instrument, so as to accumulate their effects in one photograph. For identification the spark between iron electrodes was also photographed, but with a shutter over the lower part of the slit, so that the image of the spark should occupy only the upper part of the field.

The following is the list of wave-lengths of the iron lines thus photographed:—

4414·7	3885	3734·5
4404·2	3877·4	M 3727
4382·8	3859·2	3719·6
4325·2	3849·7	3709
4307·2	3840·3	3705·5
4271·3	3833·6	3647
4250·5	3827·6	3631
4201·5	3825·2	3618
4143·1	L 3819·3	3608·2
4131·5	3815·3	N 3580·5
4071	3799·3	3568·9
4062·9	3795	3564
4045	3787	3525·7
4004·7	3766·6	3496·8
3967	3763·4	3489·8
3929·7	3757·7	3476
3927·2	3749·5	3465·5
3922	3747·2	O 3440
3920	3745·3	
3902·5	3736·5	T 3019·8
3898·4		

As a rule no iron lines above O make their appearance; in a few plates T is visible, and it is possible that other lines may be obscured by the water spectrum, which always comes out and extends from near S to below R. Above T no line at all is visible in any of the photographs, though the spark lines come out strongly enough, and several of

* A Paper read before the Royal Society, April 3rd, 1884.

the strongest groups of iron lines, both of spark and arc lines, are in the region beyond T.

The spark by which the gas was fired passed in general between a platinum wire and the side of the small brass tube, and was out of view; but in order to make quite sure that the lines were not due at all to the spark, the brass tube was lined with a tube of platinum foil which projected beyond the brass tube a short distance into the larger tube, and the spark passed between the platinum wire and the platinum tube. It was found that the same iron lines made their appearance in the flash whichever way the spark was passed.

Other experiments were made with explosions of carbonic oxide and oxygen, and with coal-gas and oxygen. The explosions of these gases were attended with much more continuous spectrum, and the metallic lines were not always as well developed as they were with hydrogen and oxygen; but on the whole there were as many metallic lines photographed from the flashes of carbonic oxide as from those of hydrogen. There is an uncertainty about the explosion of the carbonic oxide mixture which we cannot account for, even when we take into account the remarkable effects of relative dryness of the gas on the explosions discovered by Mr. Dixon. Sometimes the explosions were so violent as to break the plate closing the end of the tube, though this had resisted the explosions of the hydrogen mixture, while at other times the wave of explosion passed slowly along the tube. The gas was in all cases confined over water, and passed directly from the gasholder into the tube.

When the iron tube was lined with copper-foil, only one copper line in the visible spectrum, $\lambda = 5104{\cdot}9$, was seen, and in the ultra-violet two lines, λ 3272 and λ 3245·5. All three lines were very strong, and the two ultra-violet lines were in some cases reversed. These lines were also frequently developed when no copper lining was in the tube, probably from the brass of the small side tubes.

Copper also gave a line in the indigo, λ 4281 about, decidedly less refrangible than the copper line, λ 4275, coincident apparently with the strong edge of one of the bands developed when a copper salt is held in a Bunsen burner.

A lining of copper which had been electroplated with nickel developed only one Ni line, λ 5476, in the visible part of the spectrum, but gave by photography the following lines in the ultra-violet :—

3807·5	3524	3445·5
? 3641	3514·7	3432
3618·3	3510	3422
3783	3492	3413·2
3775	3461·5	3391·5
3612·5	3457·7	3378·4
3597·3	3453	3369·6
3571·5	? 3451	3367·4
3565		

When nickel oxalate was put into the tube, lines with wave lengths 3670·5, 3470·3, and 3389·6 in addition to the preceding were developed. It is doubtful whether the line λ 3451 be a nickel line. That at $\lambda = 3453$ is ascribed to cobalt by Cornu, but it seems to be a nickel line as well.

When copper wire electro-plated with cobalt was put into the tube cobalt lines appeared with the approximate wave-lengths.

4119	3594	3492 ?
4089	3567	3474
3997	3528	3462
3911	3525	3453
3894	3522	3431
3871	3502	3411
3845	3495	3403
3601		

The lines λ 3528 to 3522 form a continuous band in the photograph, so that these three lines may not represent the whole group at that spot. It is doubtful whether λ 3492 be a cobalt line as well as a Ni line.

No other metal gave anything like the number of lines that were given by iron, nickel, and cobalt.

A lining of lead gave the lines λ 4057, 3683·3, and 3639·3 strongly, and these lines were frequently developed, though less strongly, when there was no lead lining; the metal being without doubt derived from the leaden washers used to make the ends of the tube air-tight.

A strip of silver gave the lines λ 3381·5 and 3278, and these lines were sometimes reversed. No trace of the channelled spectrum of silver was developed even when silver oxalate was put into the tube, and furnished plenty of silver dust after the first explosion.

A magnesium wire about 2 millims. thick and two-thirds the length of the tube gave the *b* lines very well; that is to say b_1 and b_2 were well developed, and b_4 was also seen, but as the iron and the magnesium components of b_4 are very close together, and the iron line had been observed before the introduction of the magnesium, it was not possible to say with certainty whether or not the magnesium line were present too. No other magnesium line could be detected. The blue flame line was carefully looked for, but could not be seen. The photographs showed none of the magnesium triplets in the ultra-violet, nor any trace of the strong line λ 2852, which appears in the flame of burning magnesium, and is yet more conspicuous in the arc when that metal is present.

Metallic manganese, introduced into the tube in coarse powder, gave the group at wave-length about 4029 with much intensity, but no other manganese line with certainty. In the visible part of the spectrum the channellings in the green due to the oxide were visible.

A lining of zinc produced no zinc line, and zinc-dust gave only a very doubtful photographic impression of the line λ 3342. A strip of cadmium gave no line of that metal either in the visible, or in the ultra-violet part of the spectrum.

Tin, aluminium, bismuth, and antimony, also failed to produce a line of any of those substances, and so did mercury which was spread over copper foil made to line the tube.

Thallium spread as amalgam over the copper lining gave the lines λ 3775·6, 3528·3 and 3517·8.

Chromium was introduced as ammonium bichromate, which of course left the oxide after the first explosion. This gave the chromium lines with wave-lengths about 5208, 5205, 5204, 4289, 4274·5, 4253·5, very well and persistently, also the lines with wave-lengths about 3605, 3592·5, 3578·5.

Sodium salts (carbonate, chloride) developed the ultra-violet line λ 3301; and potassium salts give the pair of lines about wave-length 3445; but no more refrangible line of either metal was depicted on the photographs. Lithium carbonate gave, besides the lines in the red, orange, green, and blue, the violet line, λ 4135·5; but no more refrangible line.

Photographs of a flame of mixed coal-gas and oxygen, in which an iron wire was burnt, show, as might be expected, the same iron lines as are developed in the flash of the detonating gases, and of the same relative intensities. These intensities are not quite the same relatively as they are in the arc spectrum. Thus the lines λ 3859, 3745, 3737, 3735, and 3719 come out in great strength, much stronger than the lines λ 3647, 3631, 3618, which are remarkably strong in the arc.

German-silver wire, burnt in the flame of coal-gas and oxygen, gave the same nickel lines as were given by nickel in the detonating gases, as well as those of copper and lead.

Copper wire gave, besides the lines λ 3274, 3245·5, a set of bands in the blue, which correspond with those given by copper salts in flames, and are probably due to the oxide.

The greater part of the lines which we have observed in the flames of the exploding gases have been observed by

us to be reversed when the several metals were introduced into the arc in a crucible of lime or magnesia; which is quite in accord with the supposition that the metals experimented on are volatile, and emit as well as absorb these particular rays at temperatures lower than that of the arc.

That iron is volatile at a temperature below the fusing point of platinum, which is about 1700° C., has been pointed out by Watts (*Phil. Mag.*, vol. xlv., p. 86), who observed in the flame of a Bessemer converter almost all the green and blue lines of iron which we have seen in the exploding gases, besides one or two lines which we have not observed or identified. Having regard to this volatility of iron, it does not seem so surprising that iron lines should be observed accompanying those of hydrogen to great heights in the sun's atmosphere as that they should not be always seen there.

It is remarkable that such volatile metals as mercury, zinc, and cadmium should give no lines in the flame of the exploding gases.

The gases exploded in the tube were generally mixed in nearly the proportions in which they combine chemically; but experiments were made with oxygen in excess and also with hydrogen and carbonic oxide in excess, a small excess of any one of the gases did not seem sensibly to affect the result, but on the whole the metallic lines were more certainly developed when there was not much excess of oxygen, and more constantly developed when hydrogen was used than when carbonic oxide was used.

The absence of any metallic lines in the flame of the exploding gases which are more refrangible than T may be in part due to a falling off in the sensibility of the photographic plates for light of shorter wave-length; but as the spark lines of iron seem to be quite as strongly depicted on the plates in regions of the spectrum far above T as they are in the regions below, we think that want of sensitiveness in the plates cannot be the only reason for the absence of higher lines, but that the emissive power of the metals for these lines is feeble at the comparatively low temperature of the flame.

Gony (*Comptes Rendus*, 1877, p. 232), using a modification of Bunsen's burner fed with gas mixed with spray of metallic salts, observed at the points of the inner green flame three or four iron lines which we have not observed in the flame of the detonating gas, the lines b_1 and b_2 of magnesium, two cobalt lines in the blue, which we have not seen, one line of zinc, and one of cadmium, and the two strong green rays of silver. Can the appearance of these rays under these circumstances imply that the temperature of the inner green cone of a Bunsen burner, when the proportion of air to coal-gas is near the exploding point, is higher than that of the explosion of hydrogen and oxygen?

The interesting theoretical questions which are suggested by the facts recorded in this paper we must leave for future discussion.

Cheap Engine for Raising Water—An inquiry has just been held at Goole by Mr. J. T. Harrison, C.E., one of the Inspectors of the Local Government Board, with reference to the Local Board borrowing £6000 for works of sewage and street-making. The scheme was prepared by Mr. E. C. Buchanan Tudor, C.E., surveyor to the Board, who explained the plans in detail. There was no opposition, and the scheme was favourably considered. Mr. Tudor has also prepared and carried out a scheme for the south side of the town in Old Goole, which was visited by Mr. Harrison for the purpose of seeing the flushing arrangements, designed by Mr. Tudor, by pumping water from a deep bore hole with one of Bailey's hot-air engines, raising water 30 ft. high to a tank holding 21 tons. For 4d. per day for fuel, the whole contents of the tank are discharged down either line of 15-in. pipe in 120 secs. This is believed to be the cheapest method of raising water that has ever been discovered.—*Manchester City News.*

SUPERPHOSPHATE AND SUPERPHOSPHATE.

By FREDK. JAS. LLOYD, F.C.S.,
Lecturer on Agriculture, King's College.

MOST chemists, probably all agricultural chemists, are acquainted with the voluminous reports of Mr. T. Jamieson, in which, for some years past, he has recorded the results of his agricultural experiments, conducted formerly in Aberdeenshire, more recently in Sussex. They have led him to the conclusion that superphosphate is not merely an expensive and unnecessary manure, but an absolutely injurious one. Now the conclusion, if just, is of paramount importance to every agricultural chemist, to say nothing of the revolution which it would produce in the manufacturing world. It is, therefore, in my opinion, the duty of every agricultural chemist to sift the matter thoroughly, and without bias, and to determine for himself whether the results obtained justify the conclusion drawn. That Mr. Jamieson's experiments have been so conducted as to be open to severe criticism cannot be doubted, yet there is something in the results obtained which all the criticism the experiments have received fails to account for. This opinion is held by many, especially by agriculturists, who therefore believe that the experiments are of value in spite of the obloquy which has been thrown upon them.

What has struck me as most peculiar is the fact that no other experimenter, and there have been many, working at the same question, has confirmed Mr. Jamieson's results. This led me to ask the question, Does Mr. Jamieson use superphosphate similar to the superphosphate used by others in their experiments; in other words, has he used ordinary commercial superphosphate?

In Mr. Jamieson's reports the analyses of the manures he has used are given, though stated in a somewhat different style to that ordinarily employed by chemists.

The following is a copy of the analyses as given:—

Dissolved Coprolites.

	Aberdeenshire.			Sussex
	1876.	1878.	1880.	1882.
Water	12·18	17·00	14·23	15·67
Organic matter, alkaline salts, &c.	0·98	3·80	5·20	7·56
Phosphoric anhydride	19·01	16·01	13·81	14·90
Sulphuric anhydride	25·22	31·81	37·51	33·06
Carbonic anhydride	1·65	—	—	—
Sand	7·23	3·68	3·92	4·25
Lime	29·08	25·31	22·53	23·25
Magnesia	0·41	—	—	—
Iron and alumina	4·24	2·39	2·80	1·31
	100·00	100·00	100·00	100·00
Phosphoric anhydride soluble in water	9·49	12·00	12·45	11·75

It is possible to calculate from these data what is the exact composition of the superphosphates. The soluble phosphoric anhydride will be present as monocalcic phosphate. The remainder of the phosphoric acid will presumably be present as tricalcic phosphate—there might perhaps be some phosphate of iron, but it will be preferable to calculate the iron as sulphate. The lime not combined with phosphoric acid will exist as calcium sulphate. These calculations enable us to determine how much of the sulphuric anhydride exists in the superphosphates as free sulphuric acid. Moreover, by combining the constituents in this manner only a minimum of free sulphuric acid is shown, but probably some of the iron would not be present as sulphate, so that the amount of free sulphuric acid would be rather more than that stated.

The following table gives the analyses as obtained by these calculations, and these analyses may be fairly assumed to represent the composition of the superphosphates employed by Mr. Jamieson. By the side of these manures I have placed an analysis of a superphosphate which re-

presents the ordinary commercial article as supplied to and used by farmers throughout the country.

Composition of Superphosphates.

	Aberdeenshire.		Sussex.		Ordinary article.
	1876.	1878.	1880.	1882.	
Moisture	12·18	17·00	14·23	15·67	17·05
Organic matter &c...	5·96	3·80	5·20	7·56	4·94
Monocalcic phosphate	13·23	16·73	17·36	16·38	16·63
Equal to tricalcic phosphate (rendered soluble) ..	(20·72)	(26·19)	(27·18)	(25·65)	(26·04)
Insoluble tricalcic phosphate	20·78	8·75	2·97	6·87	3·52
Sulphate of lime ..	29·09	38·47	38·87	36·18	39·37
Sulphate of iron ..	8·48	4·78	5·60	2·62	6·16
Sulphuric anhydride *present as free acid*	3·05	6·79	11·85	10·47	3·32
Silica	7·23	3·68	3·92	4·25	9·01
	100·00	100·00	100·00	100·00	100·00

There is, then, an exceptional amount of free sulphuric acid in the manures which have been employed by Mr. Jamieson of late years; indeed, they must have been saturated with sulphuric acid, and the conclusion to which I am driven is that the superphosphate used by Mr. Jamieson in his experiments does not represent the superphosphate of commerce, the manure used by farmers throughout the country.

Thus, the difference between Mr Jamieson's results and the results of other experimenters is accounted for, and here also, I think, is the true explanation of some of Mr. Jamieson's extraordinary conclusions, conclusions which may be true of these special superphosphates, but are certainly not applicable to the general farming of the country.

Agricultural Laboratory,
4, Lombard Court, E.C.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING APRIL 30TH, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, May 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 161 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily (excepting during the Easter holidays), from April 1st to April 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

The general excellence in character of the water supplied during the previous quarter has been more than maintained by the supply of the past month. Of the 161 samples of water examined, the whole were, without exception, well filtered, clear, and bright. Their aëration was abundant; and in respect to degree of freedom both from colour and organic matter, their condition was wholly satisfactory. In no one sample was there found an excessive proportion of organic carbon; while the mean proportion amounted to 0·126 part in 100,000 parts of water, corresponding to less than a quarter of a grain of organic matter per gallon.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ESTIMATION OF PHOSPHORIC ACID.

REPORT OF THE SUB-COMMITTEE OF THE CHEMICAL TRADES SECTION OF THE LONDON CHAMBER OF COMMERCE.*

AT a meeting of the representatives of the Chemical Trades, which included, by invitation, non-members as well as members of the Chemical Trades Committee, held on March 14, the following resolution was passed:—"That the professional chemists be invited to meet and consider what means, if any, they can suggest by which the most accurate mean result may be arrived at, by any two chemists who may be named, in any Phosphate or Superphosphate contract."

At the first meeting on April 2 Mr. Ogston was asked to take the chair, and after a full discussion of all the matters relating to analysis and phosphates that had been mentioned at the various meetings of the Section, and having particular regard to the statements made by many of the representatives of the chemical trades, at the meeting held on March 14, it was proposed and seconded and resolved that before discussing any differences of methods, employed by the several members of the sub-committee, it would be desirable to ascertain what variation would be found in the analysis of a properly-prepared sample when made by the several analysts. Such a sample of Charleston Phosphate was prepared by two members of the committee, and a portion sent to each one for analysis by their ordinary methods. The results were compared at their next meeting, and the following figures represent the five determinations of Phosphoric Acid:—

Nos.	1.	2.	3.	4.	5.
Phosphoric acid ..	26·55	26·20	26·48	26·60	26·00
Equal to phosphate of lime	57 96	57·19	57·82	58·06	56·75

It will be seen here that the differences are not large, and probably do not vary to a greater extent than may be expected in substances of this character, and considering that in all cases the mean of two analyses are taken, the variation cannot be said to be of any serious importance. Upon discussion it was found that in four cases out of the five the "Magnesian" method alone had been employed in the analyses, and that in the fifth the mean of one test by that method and another by the Molybdenum process had been taken, the difference between the two being one-half per cent in the phosphoric acid.

It would appear from these results of the analysis of a phosphate,—by no means of the simplest composition—that fairly uniform percentages of phosphoric acid are indicated, and that there is uniformity of method in the practice adopted by the reporters, and as they believe by all the principal analysts engaged in the examination of phosphates in this country. The sample that was reported upon was, of course, prepared very carefully, but not more carefully than samples should always be dealt

* As confirmed by the Chemical Trades Section on April 30, 1884, and ordered to be printed and circulated.

with before being forwarded for analysis, and in reference to this part of the question it was agreed—

1st. That the manufacturers should be asked to send the ground samples in a very finely divided state, with a separate sample coarsely crushed, in which the determination of the water shall be made.

2nd. That the phosphoric acid shall be determined in the ground sample dried at 212° F. The moisture to be separately estimated in this, if it be desired, as well as in the rough sample.

3rd. That in the event of there being a difference of more than 1½ in the results of the two chemists in the phosphate of lime, these results shall be communicated to both of them, and their opinion requested as to the cause of difference.

It will be seen that the extreme difference in the five analyses above referred to is 1¼ per cent in the phosphate of lime, and it is thought that it should not exceed 1½ per cent, in samples finely ground and prepared as we recommend.

(Signed) G. H. Ogston,
John Hughes,
H. R. Smith,
Bernard Dyer,
F. E. J. Cridland.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ANTIMONY.

(Concluded from p. 220).

The newer atomic weights found in the previous chapters of this work will be applied to the discussion of all these series further along. It may, however, be properly noted at this point, that the probable errors assigned to the percentages of oxygen in three of Kessler's series are too low. These percentages are calculated from the quantities of $KClO_3$ involved in the several reactions, and their probable errors should be increased with reference to the probable error of the molecular weight of that salt. The necessary calculations would be more laborious than the importance of the figures would warrant, and, accordingly, in computing the final general mean for antimony, Kessler's figures will receive somewhat higher weight than they are legitimately entitled to.

Naturally, the concordant results of Dexter, Kessler, and Dumas led to the general acceptance of the value of 122 for antimony as against the lower figure of 120 of Schneider. Still, in 1871, Unger† published the results of a single analysis of Schlippe's salt, $Na_3SbS_4.9H_2O$. This analysis gave Sb = 119·76, if S = 32 and Na = 23, but no great weight could be attached to the determination. It served, nevertheless, to show that the controversy over the atomic weight of antimony was not finally settled.

More than ten years after the appearance of Kessler's second paper the subject of the atomic weight of antimony was again taken up, this time by Professor Cooke. His results appeared in the autumn of 1877,‡ and were conclusive in favour of the lower value, approximately 120. For full details the original memoir must be consulted; only a few of the leading points can be cited here.

Schneider analysed a sulphide of antimony which was already formed. Cooke, reversing the method, effected the synthesis of this compound. Known weights of pure antimony were dissolved in hydrochloric acid containing a little nitric acid. In this solution weighed balls of antimony were boiled until the liquid became colourless; subsequently the weight of metal lost by the balls was ascertained. To the solution, which now contained only antimonious compounds, tartaric acid was added, and then with a supersaturated aqueous sulphhydric acid, antimony trisulphide was precipitated. The precipitate was collected by an ingenious process of reverse filtration, converted into the black modification by drying at 210°, and weighed. After weighing, the Sb_2S_3 was dissolved in hydrochloric acid, leaving a carbonaceous residue unacted upon. This was carefully estimated and corrected for. About two grms. of antimony were taken in each experiment and thirteen syntheses were performed. In two of these, however, the antimony trisulphide was weighed only in the red modification, and the results were uncorrected by conversion into the black variety and estimation of the carbonaceous residue. In fact, every such conversion and correction was preceded by a weighing of the red modification of the Sb_2S_3. The mean result of these weighings, if S = 32, gave Sb = 119·994. The mean result of the corrected syntheses gave Sb = 120·295. In these eleven experiments the following percentages of S in Sb_2S_3 were established:—

28·57
28·60
28·57
28·43
28·42
28·53
28·50
28·49
28·58
28·50
28·51

Mean 28·5182 ± 0·0120

These results, confirmatory of the work of Schneider were presented to the American Academy in 1876. Still before publication, Cooke thought it best to repeat the work of Dumas, in order to detect the cause of the old discrepancy between the values Sb = 120 and Sb = 122. Accordingly, various samples of antimony trichloride were taken, and purified by repeated distillations. The final distillate was further subjected to several recrystallisations from the fused state; or, in one case, from a saturated solution in bisulphide of carbon. The portions analysed were dissolved in concentrated aqueous tartaric acid, and precipitated by silver nitrate, many precautions being observed. The silver chloride was collected by reverse filtration, and dried at temperatures from 110° to 120°. In one experiment the antimony was first removed by H_2S. Seventeen experiments were made, giving, if Ag = 108 and Cl = 35·5, a mean value of Sb = 121·94. If we reduce to a common standard, Cooke's analyses give, as proportional to 100 parts of AgCl, the quantities of $SbCl_3$ stated in the third column:—

1·5974 grms.	$SbCl_3$	gave 3·0124	AgCl.	53·028
1·2533	,,	2·3620	,,	53·061
0·8876	,,	1·6754	,,	52·978
0·8336	,,	1·5674	,,	53·184
0·5326	,,	1·0021	,,	53·148
0·7270	,,	1·3691	,,	53·101
1·2679	,,	2·3883	,,	53·088
1·9422	,,	3·6646	,,	52·999
1·7702	,,	3·3384	,,	53·025
2·5030	,,	4·7184	,,	53·048
2·1450	,,	4·0410	,,	53·081
1·7697	,,	3·3281	,,	53·175
2·3435	,,	4·4157	,,	53·072
1·3686	,,	2·5813	,,	53·020
1·8638	,,	3·5146	,,	53·030
2·0300	,,	3·8282	,,	53·028
2·4450	,,	4·6086	,,	53·053

Mean 53·066 ± 0·0096

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Archiv. der Pharmacie*, 197, 194. Quoted by Cooke.

‡ *Proceedings American Academy*, v. 13.

This mean may be combined with that of Kessler's series, as follows:—

Kessler	53·623 ±	0 015
Cooke	53·066	0·0096
General mean ..	53·2311	0·008

The results thus obtained with $SbCl_3$ confirmed Dumas's determination of the atomic weight of antimony as remarkably as the syntheses of Sb_2S_3 had sustained the work of Schneider. Evidently, in one or the other series a constant error must be hidden, and much time was spent by Cooke in searching for it. It was eventually found that the chloride of antimony invariably contained traces of oxychloride, an impurity which tended to increase the apparent atomic weight of the metal under consideration. It was also found, in the course of the investigation, that hydrochloric acid solutions of antimonious compounds oxidise in the air during boiling as rapidly as ferrous compounds; a fact which explains the high values for antimony found by Kessler

In order to render "assurance doubly sure," Professor Cooke also undertook the analysis of the bromide and the iodide of antimony. The bromide, $SbBr_3$, was prepared by adding the finely powdered metal to a solution of bromine in carbon disulphide. It was purified by repeated distillation over pulverised antimony, and by several recrystallisations from bisulphide of carbon. The bromine determinations resembled those of chlorine, and gave, if Ag = 108 and Br = 80, a mean value for antimony of Sb = 120.

Reduced to a common standard, the fifteen analyses give the subjoined quantities of $SbBr_3$ proportional to 100 parts of silver bromide:—

1·8621 grms.	$SbCr_3$ gave	2·9216	AgBr.	63·736
0·9856	,,	1·5422	,,	63·909
1·8650	,,	2·9268	,,	63·721
1·5330	,,	2·4030	,,	63·795
1·3689	,,	2·1445	,,	63·833
1·2124	,,	1·8991	,,	63·841
0·9417	,,	1·4749	,,	63·848
2·5404	,,	3·9755	,,	63·901
1·5269	,,	2·3905	,,	63·874
1·8604	,,	2·9180	,,	63·756
1·7298	,,	2·7083	,,	63·870
3·2838	,,	5·1398	,,	63·890
2·3589	,,	3·6959	,,	63·825
1·3323	,,	2·0863	,,	63·859
2·6974	,,	4·2285	,,	63·791

Mean 63·830 ± 0·008

The iodide of antimony was prepared like the bromide, and analysed in the same way. At first, discordant results were obtained, due to the presence of oxyiodide in the iodide studied. The impurity, however, was removed by subliming the iodide in an atmosphere of dry carbon dioxide. With this purer material, seven estimations of iodine were made, giving, if Ag = 108 and I = 127, a value for antimony of Sb = 120. Reduced to a uniform standard, Cooke's weighings give the following quantities of SbI_3 proportional to 100 parts of silver iodide:—

1·1877 grms.	SbI_3 gave	1·6727 grms.	AgI.	71·005
0·4610	,,	0·6497	,,	70·956
3·2527	,,	4·5716	,,	71·150
1·8068	,,	2·5389	,,	71·165
1·5970	,,	2·2456	,,	71·117
2·3201	,,	3·2645	,,	71·071
0·3496	,,	0·4927	,,	70·956

Mean 71·060 ± 0·023

Although Cooke's work was practically conclusive, as between the rival values for antimony, his results were severely criticised by Kessler,* who, evidently, had read Cooke's paper in a very careless way. On the other hand, Schneider published in *Poggendorff's Annalen* a friendly review of the new determinations, which so splendidly vindicated his own accuracy. In reply to Kessler, Cooke undertook still another series of experiments with antimony bromide,* and obtained absolute confirmation of his previous results. To a solution of antimony bromide was added a solution containing a known weight of silver not quite sufficient to precipitate all the bromine. The excess of the latter was estimated by titration with a normal silver solution. Five analyses gave values for antimony ranging from 119·98 to 120·02, when Ag = 108 and Br = 80. Reduced to a common standard, the weights obtained gave the amounts of $SbBr_3$ stated in the third column as proportional to 100 parts of silver:—

2·5032 grms.	$SbBr_3$ =	2·2528 grms.	Ag.	111·115
2·0567	,,	1·8509	,,	111·119
2·6512	,,	2·3860	,,	111·115
3·3053	,,	2·9749	,,	111·106
2·7495	,,	2·4745	,,	111·113

Mean 111·114 ± 0·0014

Schneider, also,† in order to more fully answer Kessler's objections, repeated his work upon the Arnsberg stibnite This he reduced in hydrogen as before, correcting scrupulously for impurities. The following percentages of sulphur were found:—

28·546
28·534
28·542

Mean 28·541 ± 0·0024

These figures confirm his old results, and may be fairly combined with them and with the percentages found by Cooke, as follows:—

Schneider, early series	28·520 ±	0·038
,, late ,, ...	28·541	0·0024
Cooke..	28·5182	0·0120
General mean	21·5385	0·0023

We have now before us the following ratios, good and bad, from which to calculate the atomic weight of antimony. The single results obtained by Weber and by Unger, being unimportant, are not included:—

(1). Percentage of S in Sb_2S_3, 28·5385 ± 0·0023
(2). ,, Sb in Sb_2O_4, 79·283 ± 0·009
(3). O needed to oxidise 100 parts $SbCl_3$, 7·0294 ± 0·0024
(4). O ,, ,, Sb_2O_3, 10·953 ± 0·0075
(5). O ,, ,, Sb, 13·079 ± 0·0096
(6). $K_2Cr_2O_7$: tartar emetic :: 100 : 337·30 ± 0·29
(7). Ag : $SbCl_3$ :: 100 : 70·512 ± 0·021
(8). AgCl : $SbCl_3$ :: 100 : 53·2311 ± 0·008
(9). Ag : $SbBr_3$ :: 100 : 111·114 ± 0·0014.
(10). AgBr : $SbBr_3$ :: 100 : 63·830 ± 0·008
(11). AgI : SbI_3 :: 100 : 71·060 ± 0·023

Three of these ratios give estimates for the molecular weight of antimony trichloride, and two give corresponding values for the bromide. These values may be combined, as follows: first, for the chloride we have—

From (3)	$SbCl_3$ = 227·094 ±	0·115
,, (7)	,, 227·771	0·091
,, (8)	,, 228·433	0·039
General mean ,,	228·225	0·034

Hence Sb = 122·115 ± 0·055.

For the bromide we get—

From (9)	$SbBr_2$ = 358·926 ±	0·032
,, (10)	,, 358·935	0·060
General mean ,,	358·929	0·029

Hence Sb = 119·625 ± 0·063.

* *Ber. d. Deutsch. Chem. Gesell*, 12, 1044. 1879.

* *Amer. Journ. Sci. and Arts*, May, 1880. *Berichte*, 13, 951.
† *Journ. f. Prakt. Chem.*, (2), 22. 131.

From all the data eight values for Sb may be deduced. These fall into two groups; the one near the number 120, the other not far from 122. In making the calculation the atomic weights found in previous chapters are applied; the value selected for chromium being that deduced from Siewert's experiments:—

1.	From Sb_2S_3, ratio (1) ..	Sb = 120·145	±0·045	Low
2.	„ $SbBr_3$	„ 119·625	0·063	Low
3.	„ SbI_3, ratio (11) ..	„ 119·665	0·179	Low
4.	„ tartar emetic, ratio (6)	„ 118·690	0·278	Low
5.	„ Sb_2O_4, ratio (2) ..	„ 122·181	0·061	High
6.	„ $SbCl_3$	„ 122·115	0·055	High
7.	„ ratio (4)	„ 121·798	0·105	High
8.	„ „ (5)	„ 122·053	0·094	High
	General mean	„ 121·027	0·025	
	General mean of values 1 to 4 ..	„ 119·935	0·036	
	„ „ 5 „ 8 ..	„ 122·092	0·035	

Although the means of the four lower values and of the four higher values are thus shown to be approximately equal in weight, we know from Cooke's experiments that the larger mean is vitiated by serious constant errors. Only in value 5, the result calculated from Dexter's experiments, has the constant error not been pointed out. Cooke considers it probable, however, that the Sb_2O_4 involved in this work contained traces of some lower oxide, which, if present, would render the atomic weight of antimony apparently too high. Chemically considered, the preponderance of evidence is strongly in favour of values 1 to 3, deduced from the experiments of Schneider and of Cooke. These give a general mean of Sb = 119·955 ± 0·036; or, if O = 16, this becomes Sb = 120·231.

This we may accept as most nearly the true result, and reject the data of Dexter, Dumas, and Kessler altogether.

Since this chapter was written, Pfeifer has compared the amount of antimony thrown down electrolytically, with the quantity of silver deposited by the same current in the same time. From rather meagre data he concludes that the atomic weight of antimony, thus determined, may be 121. Additional investigation is promised. The figures thus far published would weigh little as against Cooke's experiments. (*Ann. Chem. Pharm.*, 209, 161. 1881).

The following additional note has been communicated by the author:—

Since the foregoing chapter was first published, the following results have been obtained by Bongartz*:—Pure antimony was converted into sulphide, by solution in warm K_2S and precipitation by H_2SO_4. The sulphide was then oxidised with H_2O_2, and the sulphur estimated as $BaSO_4$. In 12 experiments, 100 parts of Sb were found to yield of $BaSO_4$ 290·306 ± 0·0436. Hence Sb = 120·183 ± 0·023. The values given by Bongartz himself with O = 15·96, S = 31·98, and Ba = 136 8, range from 120·091 to 120·390; in mean, 120·193.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, May 15, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. T. Burgess, E. J. Caley, R. D. Courtney, M. H. Foye, W. F. Grace, Baron Ferdinand von Mueller, H. Rogers, A. J. Watts.

Dr. J. H. Gladstone then read a paper "*On Refraction Equivalents of Organic Compounds.*" In this paper the author gives the results of observations which have been made from time to time since 1870. These results are contained in three tables giving the refractive indices, &c., of over 140 substances. Table I. contains the refractive indices of the liquid bodies from observations of the lines A, D, and H. Table II. gives a list of the solvents employed, and the percentage amount of substance dissolved. Table III. gives the specific refraction, dispersion, and refraction equivalent of all the substances as deduced from observations, and the theoretical refraction equivalent calculated from the values of the respective elements given below. The specific refraction is the refractive index for A minus 1 divided by the specific gravity, or—

$$\frac{\mu A - 1}{d}.$$

The specific dispersion is—

$$\frac{\mu H - 1}{d} - \frac{\mu A - 1}{d},$$

or, which is the same thing,—

$$\frac{\mu H - \mu A}{d},$$

The refraction equivalent is—

$$\frac{\mu A - 1}{d} \times \text{the atomic weight.}$$

The following are the values of the elements:—Carbon saturated, 5·0; carbon in C_nH_n, 5·95; carbon double linked, 6·1; hydrogen, 1·3; oxygen joined by single bonds, 2·8; oxygen joined by a double bond, 3·4; nitrogen, 4·1; nitrogen in bases, NO_2, &c., 5·1; chlorine, 9·9; bromine, 15·3; iodine, 24·5; sulphur joined by single bonds, 14·1; sulphur joined by a double bond, 16·0. The author has not included in the tables the refraction equivalent calculated for the theoretical limit of the spectrum, because of the increasing uncertainty as to the position of such a limit. The author then gives the data by which the refraction equivalents of the above elements are calculated, and in conclusion draws special attention to two points,—the phenomena of dispersion, and the bearing of these optical phenomena on our views as to the structure of organic compounds.

Dr. Armstrong asked if Dr. Gladstone had used benzene prepared from benzoic acid, as Meyer had shown that all benzene prepared from coal-tar contained thiophene, and thus the refraction equivalent of carbon in benzene might be affected. He ventured to protest against the use of the terms double linked, double bonds, &c., which he trusted would soon become obsolete. It would be better to speak of carbon in the ethylenic condition, &c. He also thought it would be most important, if possible, to determine the specific dispersion as well as the specific refraction.

Prof. McLeod suggested that some use might be made of Capt. Abney's photographic results, and that it would be better to determine the refraction of liquids at a fixed distance from their melting-point rather than from their boiling point.

Mr. Turner then read a paper "*On the Estimation of Silicon in Iron and Steel.*" The author has estimated the silicon, in samples of iron and steel containing from 0·06 to 22 per cent of silica, by the various methods usually employed, and comes to the conclusion that the method suggested by Watts is most generally applicable, and gives, when slightly modified, accurate results. The method (*Journ. Chem. Soc. Abstracts*, xlii., 1134) consists in passing dry chlorine free from air over the iron borings at a low red-heat. The chloride of iron volatilises, and is condensed in the colder portion of the combustion-tube, whilst the silicon chloride passes on, and is decomposed by passing it through water, which on evaporation yields the silica. Any slag and the silicon contained in it remain behind in the porcelain boat unattacked. The improvement suggested by the author is the use of a Will and Varrentrapp's bulb, to contain the water by which

* *Ber. der Deutsch. Chem. Gesell.*, 16, 1942. 1883.

the silicon chloride is decomposed. The loss of the silica, which used to adhere to the delivery-tube and the beaker, is thus avoided, as the bulb can be dried and weighed after the experiment. A table accompanies the paper, giving the results obtained by six different methods and six samples of iron and steel.

Dr. Tilden then read a "*Note on the Melting-points and their Relation to the Solubility of Hydrated Salts.*" In a paper read before the Royal Society, in June, the author, in conjunction with Mr. Shenstone, proved that a relation existed between the melting-points of anhydrous salts and their solubility in water above 100°. In the present paper the author shows that a similar relation holds between the points of fusion of hydrated salts and their solubility below these temperatures. He has determined the melting-points of many salts, and gives the method by which the determinations were made. The temperature at which incipient fusion occurs is in many cases that at which the graphic curve representing the solubility suddenly turns upwards. In isomorphous salts, containing the same amount of water of crystallisation, the solubility and the fusibility stand in the same order at all temperatures below the point of fusion, the most fusible being the most soluble. The author is greatly in want of experimental data as to solubilities and melting-points, in order to extend the subject further.

A memoir detailing some minor "*Researches on the Action of Ferrous Sulphate on Plant-life*," by Dr. A. B. Griffiths. The author finds that 0·15 per cent of ferrous sulphate added to a solution of various salts aids, whilst 0·2 per cent is fatal to, the development of mustard-seeds, cabbage-plants, and some microscopic water-plants.

"*Note on Ferric Sulphocyanate*," by A. J. Shilton. The author finds that if a drop of dilute ferric chloride be allowed to fall into a solution of potassium sulphocyanide, the red colour at first formed is completely discharged. Also that a liquid containing enough ferric sulphocyanate to render it almost opaque is completely decolourised if boiled with an excess of hydrochloric acid. These effects are readily explained by the fact that the sulphocyanide is a powerful reducing agent.

The Society then adjourned to June 5th.

PHYSICAL SOCIETY.

May 10th, 1884.

Prof. F. Guthrie, President, in the Chair.

The meeting was held in the Chemical Theatre of the Mason College, Birmingham. Members had previously visited some of the factories in the town, including Gillott's Pen Works. Dr. Guthrie, President, took the chair at 3 p.m., when Prof. J. H. Poynting made a communication on "*An Experiment illustrating the Refraction of Water-Waves.*" The experiment was designed to illustrate, by means of waves in water, the refraction of waves when they pass from one medium to another in which their velocity is different. The apparatus consisted of a tank, 2 feet 6 inches square, with a plate-glass bottom. Water is poured into the tank to a depth of (say) 5 to 6 m.m. The lid of the tank consists of a calico screen, and is slightly tilted up. A lime-light under the tank projects the wave on a screen. Plates of glass, 3 or 4 m.m. thick, are placed in the tank, thus reducing the depth of water. If waves are sent across the tank they travel more slowly through the shallow water, and are seen to be refracted. When circular or lenticular plates are used the refracted waves are seen to converge to a focus.

Mr. C. J. Woodward exhibited an oxy-hydrogen lantern suitable for lecture purposes.

Dr. J. H. Gladstone took the chair, and Prof. Guthrie, President, exhibited a sealed tube containing 46·6 of tri-ethylamine and 53·4 of water. At temperatures between 0° C. and 18·3° C. the liquid forms a clear mixture. At 18·3° it becomes turbid, and at 26° C. almost perfect separation is effected. It was stated that all proportions of the two liquids containing about 15 per cent and 50 per cent of tri-ethylamine become turbid at the same temperature. A mixture containing 4 per cent requires a temperature of 41° C. to produce turbidity, while one containing 90 per cent is turbid at 6° C. A series of sealed glass bulbs, containing the liquid in different proportions, can be employed to indicate the fever temperature of the body if placed under the tongue. The author also showed the connection between such separation by heat and the separation between the same two bodies by cold, whereby in the latter case, according to the strength of the solution, either ice or subcryohydrate is separated until the composition and temperature of the cryohydrate is reached (19·2 per cent; −3·8° C.). The peculiar white condensed vapour of the chloride of tri-ethylammonium was exhibited. The white fume of this body so quickly aggregates into masses that the shapes of the smoke lines and curls are preserved.

Dr. Gladstone agreed with the author in supposing that the separation of tri-ethylamine and water was continuous in nature with the separation of ammonia from water by heat.

Dr. Tilden exhibited a tube containing a cold clear solution of amylic alcohol in water, which became turbid on gently warming and clear again on heating to about 60° C. He suggested that a similar re-mixing might take place with ethylamine and water.

Prof. Silvanus P. Thompson recalled the experiments of Prof. Ramsay on the critical states described by Andrews, and the failure of a body beyond the critical condition to retain in solution the substances it held as a liquid.

Mr. W. Lant Carpenter suggested the microscopic examination of the tri-ethylamine and water mixture at its critical temperature.

Members then visited the College rooms.

CORRESPONDENCE.

ENSILAGE.

To the Editor of the Chemical News.

Sir,—The paper on ensilage by Mr. F. J. Lloyd in the Chemical News, vol. xlix., p. 210, contains some valuable suggestions, and should assist in elucidating a very difficult and complicated subject.

Mr. Lloyd bases his arguments upon some analyses of the grass put in, and the silage taken from the experimental silo constructed by Lord Egerton at Tatton Park, the results of which were contained in a paper of mine published in the *Journal of the Royal Agricultural Society*. In that paper I limited my observations to a plain statement of facts, and left the figures to speak for themselves, but in a paper lately published in the *Journal of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society*, I have entered more fully into the chemistry of the subject, and have drawn such conclusions as I believe are warranted by the facts of the case. Under these circumstances I may perhaps be allowed to offer a few words of explanation and correction with regard to Mr. Lloyd's paper.

The grass which I analysed was pitted in July 4, and its position carefully noted. The filling was performed as follows:—

Total acreage mown, July	4	..	..	..	2½
,,	,,	,,	,,	5	..	..	..	1½
,,	,,	,,	,,	27	..	..	..	1¼
								5¼

having a total weight of 16 tons 11 cwts. 2 qrs. 22 lbs., including 2 cwts. 2 qrs. 16 lbs. of salt. On July 14 the

grass level was 8 ft. 6 ins., showing a shrinkage of 4 ft., and it subsequently sank still further. From the data obtained it was calculated that the grass, from which the sample originally analysed was taken, would be found at a distance of about 1 ft. 6 ins., from the bottom, and to avoid error two samples of silage, one taken from between 1 ft. and 1 ft. 6 ins. from the bottom, and the other from between 1 ft. 6 ins. and 2 ft., were analysed. The sample taken from the bottom layer was analysed to determine to what extent the excess of water had influenced the quality and the nature of the fermentation, and not with a view of ascertaining the composition of the bulk of the silage. It is clear, therefore, that any comparisons which are made between the analyses of the grass and the silage must be limited to those samples taken from the two upper layers just indicated, and must not include the wet and spoiled bottom layer, of which no analysis was originally taken. Mr. Lloyd has, however, based his calculations upon the assumption that the silo was only 2 ft. deep, and that it is, therefore, necessary to include the bottom layer. He has further multiplied the analysis of this wet and spoiled portion by 2, in taking the average composition of the silo. No doubt such a proceeding would be perfectly justifiable if the silage had only occupied a depth of 2 ft., but as it finally stood at a height of about 9 ft., such a calculation is misleading.

Mr. Lloyd asks for an explanation of the increase in mineral matters. With regard to the increase found in my experiments, the explanation appears to me obvious. As stated above, 2 cwts. 2 qrs. 16 lbs. of salt were used in the preparation. The heavy pressure on the surface would express a portion of the juices from the grass, and this expressed juice would sink to the bottom of the silo, bringing with it a considerable portion of salt, so that the upper portion would contain less than the bottom. At Tatton Park this was proved to have occurred by the liquid which separated. As the samples of silage were taken from a part comparatively near the bottom, the excess of mineral matters is easily accounted for—as I found the excess to be due to salt. It is obvious that only the total amount of mineral matters put into the silo could be taken out, and that if an increase in percentage occurs, it must be due either to loss of water or organic matter, or to a shifting of position. The weight of the silage, compared with the weight of the grass pitted, showed that only a trifling loss had occurred, and we may, therefore, safely assume that the explanation just given is the correct one, more especially as it was confirmed by the direct results of the analyses. It seems to me probable that a similar action might occur during ensilage, even when conducted without the addition of salt. During the process, lactic, acetic, and other acids are formed, which, filtering through the silage, might readily dissolve a portion of the mineral matters contained therein, and thus produce the apparent anomaly mentioned by Mr. Lloyd.

By including the wet bottom layer in the composition of the silage the percentage of mucilage, sugar, &c., is reduced, and consequently the loss is exaggerated, while, instead of a gain in indigestible woody fibre, there is a slight loss, or, more correctly speaking, a diminution.

I would also point out that the calculations made by Mr. Lloyd are based upon the determination of nitrogen in the grass and silage. In the grass (dried at 100° C.) I found 1·60 per cent nitrogen, and in the silage (also dried at 100° C.) 1·54 and 1·56 per cent nitrogen. After making correction for the salt contained in the samples, these figures are equal to :—

	Per cent Nitrogen.
Dried grass	1·60
Dried silage (without salt)	1·68
,, ,, ,, ,, (2nd sample) ..	1·66

Showing an average gain of only 0·07 per cent. The determinations were made with every possible care, and, I doubt not, represent the truth as nearly as the method will permit, but I must offer a protest against making absolute calculations on so slender a basis. Besides the loss by fermentation, there was a loss by the solvent action of the expressed juices, and the data are not sufficiently definite to determine what loss must be attributed to fermentation and what to drainage. The total loss, however, is comparatively small, and is, I believe, fully covered by the 6 per cent calculated by Mr. Lloyd, but his separate results are apt to convey an erroneous impression, and to under-estimate the feeding-value of silage.

It, however, seems quite clear that the conversion of indigestible fibre to soluble compounds, so much talked about, has been greatly over-estimated, and it seems probable that the general conclusions of Mr. Lloyd in this respect are correct. It is also clear that the loss of substance by fermentation has, by many, been greatly exaggerated.

The most important result of my investigation is undoubtedly the direct proof that in ensilage a considerable proportion of the insoluble albumenoids are rendered soluble.—I am, &c.,

ALFRED SMETHAM, F.C.S., F.I.C.,
Consulting Chemist to the Royal Manchester, Liverpool, and North Lancashire Agricultural Society.
Analytical Laboratory, 18, Brunswick Street, Liverpool, May 12, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 14, April 7, 1884.

Specific Heats of Water and of Carbonic Acid at Very High Temperatures.—MM. Berthelot and Vieille.—The mean specific heat of watery vapour increases very slowly with the temperature, according to the formula $16{\cdot}2+0{\cdot}0019\,(T-2000)$. The mean specific heat of carbonic anhydride is increased more than threefold from 0° to 4300°, and the elementary heat is quadrupled.

Application of Faraday's Law to the Study of the Conductivity of Saline Solutions.—E. Bouty.—The law which the author has announced with relation to the electric conductivity of saline solutions may be extended to the salts with several equivalents of acid, to the double salts, and to the salts of the polybasic acids. It is merely requisite to know in what manner the salt is electrolysed, and what is the quantity of the salt equivalent to KCl. Certain double salts do not exist in dilute solutions, and behave like simple mixtures; such are the double sulphates of cobalt and ammonium, of nickel and ammonium, &c. Other double salts preserve their individuality in the most dilute solutions, such as potassium bichromate and sulphocyanide, and magnesium platino-cyanide.

New Experiments on the Liquefaction of Hydrogen. Solidification and Critical Pressure of Nitrogen.—K. Olszewski.—The use of hydrogen as a thermometric material for measuring low temperatures is the only rational and practical method. The author liquefied nitrogen by a pressure of 60 atmospheres and a temperature of −142°. Its critical pressure is 39·2 atmospheres.

Duration of the Transformation of Superheated Octahedral Sulphur into Prismatic Sulphur.—D. Gernez.—The study of the circumstances of the transformation of octahedra into prisms, under the influence of a prismatic crystal, shows that the crystals of sulphur of an octahedral form, produced under different circumstances, are not physically identical.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 4, 1883.

Behaviour of Uric Acid with Glycerin.—G. Colasanti.—Warm glycerin is one of the best solvents for uric acid.

Behaviour of Biliary Acids with Albumen, Hemialbumose, and Peptone.—Taurocholic acid precipitates albumen but not peptone, and thus serves for the separation of these bodies.

Behaviour of Biuret and Albumenoids with Solution of Copper and Alkali.—On dissolving copper hydroxide in an alkaline solution of biuret there are formed flat prismatic crystals which appear red if viewed on their flat surfaces, but yellowish green on their edges.

Acidified Solution of Sodium Chloride as a Reagent for Albumen in Urine.—W. Roberts.—A solution of 1 part sodium chloride in 2½ parts water, to which is added 5 per cent of hydrochloric acid of sp. gr. 1·052 precipitates albumen from urine.

The Optical Methods for the Determination of Hæmoglobine.—E. Branly.—This paper does not admit of useful abstraction.

The Distribution of Poisons in the Organism in Poisoned Persons.—C. Bischoff.—From the *Berichte der Deutsch. Chem. Gesellschaft*, under which it will be noticed.

Detection of Morphine in Corpses.—H. Warnecke.—The author finds that morphine, like other alkaloids, resists prolonged digestion with pepsin, pancreatin, putrescent animal matter, &c.

Pyridine in Commercial Amylic Alcohol. — L. Haitinger.—The author finds as much as 0·1 per cent of pyridine, besides other bases in amylic alcohol,—impurities which in toxicological cases may mislead the expert. The amylic alcohol should be shaken up with an acid and re-distilled before use.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xiii., Part 2.

The Influence upon Soils and Crops of Water containing Sodium Chloride and Zinc Sulphate.—Dr. F. Storp, Prof. J. Konig, and others.—It appears that the water of even large brooks may, without animal contamination, contain as much as 2 to 3 grms. sodium chloride per litre. It was found that a solution of this salt exerts a far greater solvent power upon plant-foods than does pure water, the action increasing with its concentration. This fact had been previously established by the researches of De Luna and Terreil as far as the phosphates of the alkaline earths and the silicates of potash and lime. Calcium sulphate and carbonate and magnesium carbonate were decidedly more soluble in solution of common salt than in pure water, with partial double decomposition. As a manure, sodium chloride is only exceptionally useful, as dressings with gypsum and marl produce the same effects without the accompanying dangers. Upon vegetation the action of salt was found injurious, in proportion to the concentration of the solutions. The quantities required to do injury will rarely occur in practice. The germination of seeds and the development of young plants are also interfered with by solutions of salt. The action of zinciferous waters both upon soil and plants is decidedly more injurious. Zinc sulphate occurs both in flue-dust and in the residue from the lixiviation of the ores. Zinc oxide is absorbed by the soil like potash and lime. The salts of zinc, as it might be expected, prevent the decomposition of organic matter and its passage into an assimilable condition. The basic mineral constituents of plant-food are removed from the soil, and in their place zinc and sulphuric acid are absorbed. Upon germinating seeds zinc sulphate has little injurious action in the dark, but on their exposure to light it acts as a violent and rapid poison. Water containing 0·05 grm. per litre proved fatal to willow trees.

The Production of Farm-yard Manure and its Cost.—Prof. Holdefleiss and M. Herter-Burschen.—The authors contend, on analytical evidence, that dung, allowed to remain under the animals in the various stalls, &c., is better in quality than such as is daily removed. They hold, also, that the health of the cattle is not impaired. The cost of the manure produced is 48s. yearly per cow, or 4s. per ton.

Manuring with Common Salt and the Refuse of Herrings.—E. Hequet d'Orval and A. Pagnoul.—The herring-refuse contained per cent 1·26 nitrogen, 1·19 phosphoric acid, but sodium chloride 52. The crops were poor, as might be expected.

Carnallite as a Cheap Substitute for Kainite.—Dr. Tooschke.—Kainite is readily capable of absorbing 4·5 per cent of ammonia, whilst carnallite takes up double the quantity, and is therefore preferable for sprinkling in stables and over dung-heaps. Caution is recommended in its application to beets and potatoes.

Kainite and Bone-Meal on Sandy Soils.—F. W. Steffens.—The results of 3 cwts. kainite, followed up by 1 cwt. bone-meal, gave satisfactory results. The application of 1 cwt. bone-meal in former years, without kainite, had proved apparently useless.

Manurial Experiments with Sea-Mud and Moor-Composts.—H. Enckhausen.—Both with rye and oats the sea-mud gave much better results than an equal weight of farm-yard manure. The results were, with the mud, 2500 parts of grain as against 1833 with farm-yard manure and 1500 on a similar plot of unmanured land.

The Formation of Peptone, and its Re-conversion into Albumen.—A. Pœhl.—From the *Berichte der Deuts. Chem. Gesellschaft.*

MEETINGS FOR THE WEEK

Monday, 26th.—Society of Arts, 8. "Fermentation and Distillation," by Prof. W. Noel Hartley.
Tuesday, 27th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.
—— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
Wednesday, 28th.—Society of Arts, 8. "Primary Batteries for Electric Lighting," by I. Probert.
—— Geological, 8.
Thursday, 29th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "Some Economical Processes connected with the Woollen Industry," by Dr. William Ramsay.
—— Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
Friday, 30th.—Royal Institution, 8. "Sur les Couleurs," by M. E. Mascart, at 9.
—— Society of Arts, 8. "Street Architecture in India," by C. Purdon Clarke, C.I.E.
Saturday, 31st.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

TO CORRESPONDENTS.

V. A. Wright.—Consult some standard work on chemical physics.

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THE CHEMICAL NEWS.

Vol. XLIX. No. 1279.

CHLOROPHYLL PROBABLY A COMPOUND OF IRON WITH ONE OF THE GLUCOSIDES.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, &c.

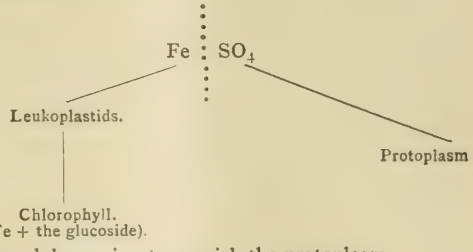
Many chemists and other scientific men have been working of late on the constitution of the green colouring matter of plants. The latest researches are those of Dr. Edward Schunck, F.R.S. (*Proceedings of the Royal Society*, vol. xxxvi., p. 183). In these interesting researches he shows that most probably chlorophyll is a glucoside. He makes an extract of leaves in boiling alcohol; the extract is allowed to settle, and then filtered; the deposit on the filter is mixed, and shaken up with its own volume of ether and with about two volumes of water. The liquid then divides into two strata—the upper green one (*a*) which Dr. Schunck says contains all the chlorophyll, and a lower yellow one, which contains tannic acid, a yellow colouring matter, a substance giving a glucose reaction with Fehling's solution (this glucose, I venture to say, is derived from the protoplasm of the plants, for I have found glucoses* in the protoplasm of living and dead cells of *Spirogyra*). Dr. Schunck now separates the two liquids, and the upper one is shaken up with a fresh quantity of water and ether until the lower layer does not give the glucose reaction. The upper liquid leaves on evaporation a green residue. If this residue be dissolved in alcohol and treated with sulphuric acid, and the alcohol evaporated off, then on adding Fehling's solution the glucose reaction is produced; thus proving that green leaves of all plants contain a glucoside, and that this glucoside, says Dr. Schunck, is very likely chlorophyll.

Now, by taking some of Dr. Schunck's green residue from the upper liquid (*a*), already referred to, dissolved in alcohol, and adding a solution of potassium ferricyanide, a blue colour was produced, most probably indicating the presence of iron.

In a previous memoir (*Transactions of the Chemical Society*, 1883, p. 195, and the *Journal of the Royal Microscopical Society*, 1883, p. 536) I have shown the existence of crystals of ferrous sulphate in close proximity to the chlorophyll granules of certain plants. It is most probable that *iron* enters into the constitution of green chlorophyll; perhaps it is a complex molecule of iron and this glucoside of Schunck. We know that no green coloured chlorophyll is produced in plants growing in soils, solutions, or other media deprived of iron. Iron, therefore, plays a most important part in the life of all plants: indirectly it is the means of the process of assimilation taking place, and also the manufacture of starch, sugars, gum, cellulose, &c., in the cells of plants.

From my already published researches† on the value of ferrous sulphate as a manure, I may say that the *iron* acts most probably as the food for the chlorophyll granules, and the *sulphur* as the food for the protoplasm of the cells, &c.; for I have grown plants to maturity in a solution containing all the inorganic salts requisite for plant life. But the whole of the sulphur in solution was in the form of sulphate in combination with dyadic iron, and not in combination with calcium or sodium; thus showing that the sulphur of the ferrous sulphate (my new manure) nourishes or acts as a food for the protoplasm or the albuminous parts of the vegetable organism, for I have found that plants will not grow if entirely deprived of sulphur in some form or other.

From my recent work on this subject it is not improbable that in the chlorophyll cells the molecules of ferrous sulphate which are taken up by the roots are constantly being decomposed, the iron combining with the colourless variety of this glucoside (*i.e.*, the leukoplastids of the vegetable physiologist), forming the green glucoside (chlorophyll):—



and the sulphur going to nourish the protoplasm.

Probably this or similar metamorphoses continue throughout the life of the plant, for, as Liebig says,—"Vitality is the power which each organ possesses of constantly reproducing itself, and for this it requires a *supply of substances* which contain the constituent elements of its own substance and are capable of undergoing transformation."

* "Notes on Loew and Bokornv's Researches on the Probable Aldehydic Nature of Albumin," Chemical News, vol. xviii., p. 179; *Journal of the Royal Microscopical Society*, April, 1884, p. 249; *Journal of the Chemical Society*, 1884 (abstracts), p. 202.

† "Experimental Investigations on the Value of Iron Sulphate as a Manure for certain Crops," *Transactions of the Chemical Society*, 1884, pp. 71-75; and the *Evening Telegraph of Philadelphia, U.S.A.*, March 8, 1884.

ATOMATION OF OXYGEN AT ELEVATED TEMPERATURES, AND THE PRODUCTION OF HYDROGEN PEROXIDE AND AMMONIUM NITRITE, AND THE NON-ISOLATION OF OZONE, IN THE BURNING OF PURIFIED HYDROGEN AND HYDROCARBONS, IN PURIFIED AIR.*

By ALBERT R. LEEDS.

It has heretofore been established, by the fact of the conversion of carbon monoxide into dioxide during the slow oxidation of phosphorus, that the formation of ozone, hydrogen peroxide, and ammonium nitrite, in the course of this eremacausis, is preceded by the resolution of the oxygen molecule into its constituent atoms. The converse of this proposition, viz., that when oxidation occurs with the contemporaneous formation of the three products enumerated, this oxidation has been preceded by the production of atomic oxygen, has not as yet been satisfactorily established, and awaits experimental proof.

The object of this second paper is to present the conflicting testimony as to whether these three bodies are formed during the rapid combustion of hydrogenous substances, and the results of a new experimental inquiry.

According to Schönbein, the formation of ozone occurred in all cases of slow oxidation in presence of atmospheric air. Moreover, that when readily oxidisable metals, like zinc and iron, were agitated in contact with air and water, hydrogen peroxide was formed. Also, that ozone, in presence of air and moisture, would generate ammonium nitrite.

This last statement, after long controversy, has been satisfactorily disproved by Carius.* Satisfactorily, because Berthelot† working independently and at a later period, has

* Reprinted from the *Journal* of the American Chemical Society, Nos. 1-2, Jan.-Feb., 1884.

* *Ann der. Chem.*, clxxiv., 31.

† *Comptes Rendus*, lxxxiv., 61.

entirely confirmed the results obtained by Carius. It has thus been established beyond reasonable doubt, that ozone in presence of moist atmospheric air or moist nitrogen will generate neither ammonium nitrite or nitrate.

At the same time it is no less certain that in the slow oxidation of phosphorus the contemporaneous formation of ammonium nitrite, ozone, and hydrogen peroxide takes place. And whilst the observations of Schönbein and others, as to the occurrence of the same phenomena in the course of the slow oxidation of metals, have not been re-investigated with the same minuteness as the oxidation of phosphorus, yet it is eminently probable that the correctness of his labours in these particulars will be eventually vindicated. In this connection, the recent controversy and final establishment of the fact of the production of both hydrogen peroxide and ammonium nitrite, when the hydrogen in palladium hydrogen undergoes slow oxidation in presence of air and moisture, is very instructive.

After the researches of Marignac, Andrews, Soret, Brodie, and others had elucidated the true nature of ozone, a very different interpretation was put upon many of the experimental results obtained by Schönbein from that put forth by their original observer. Instead of regarding, as Schönbein did, ozone or the fictitious antozone, as the starting point in certain sequences of phenomena, the hypothesis was advanced in various quarters that the real starting point was an initial change in the oxygen molecule, necessarily antecedent to all the observed phenomena.

In any new investigation of this topic it is but just to previous observers to rehearse the history of their labours, and in so doing the difficulties encountered are of two kinds:—1st. To ascertain in regard to particular experiments whether the reactions noted were in reality due to their ascribed causes. 2nd. To re-state the theoretical explanation of these phenomena in the light of the present universally received doctrines concerning the true nature of ozone.

One of the earliest observations relating to the subject matter of the present paper was that contained in a brief communication made to the Lyceum of Natural History of New York in 1869, by Loew.* His experiment was of a very simple nature. He blew a strong current of air through a fine tube into the flame of a Bunsen's burner, and collected the air in a beaker glass or balloon. He stated that in the course of a few seconds, sufficient ozone could be collected in this manner to be identified by its intense odour and the common tests.

Subsequently, a large apparatus containing many jets and burners was patented by Loew and applied to the mellowing of whiskies by means of the "ozone" thus formed.†

The production of ozone in the manner described was immediately denied by Boeke, who substituted a blast of oxygen for the air expired from the lungs, and obtained from the gaseous products the reactions and odour of a compound of nitrogen and oxygen.‡

Böttger likewise denied the accuracy of Loew's results, but upon altogether different grounds.|| He detected no ozone in air blown through the flame of a Bunsen burner, but ammonium carbonate (which he regarded as a regular constituent of air expired from the lungs), and hydrogen peroxide. In reply to these criticisms Loew repeated his experiments, using instead of expired air a bellows and a large Bunsen burner, and stated that in this manner he filled, in a short time, a large room with the peculiar odour due to ozone, while delicate tests failed to detect any peroxide of hydrogen or ammonium carbonate.

Similar experiments were performed by Than.§ This observer aspirated the products of combustion from the lower edge of the flame of a Bunsen burner through an acidulated solution of potassium iodide and starch. A blue colouration was speedily produced, the air in the wash-bottle smelling distinctly of ozone. When pure water was used as an absorbing solution and subsequently tested with potassium iodide and starch, no blue colour was developed. From this negative result the absence of ammonium nitrite was inferred, and from the previous affirmative result the presence of ozone. But the formation of ammonium nitrite as a product of combustion of hydrogen has since that time been established beyond doubt, whilst the reactions for ozone obtained by Than permit of other explanations.

Similar objections apply to the experiments performed by Struve (1871),* who endeavoured to prove that ozone, hydrogen peroxide, and ammonium nitrite are all present in the products of combustion of hydrogen. The gas was burned beneath a long drawn-out funnel, and tests were made for ozone at the upper end of the funnel, whilst the water condensed on its sides was collected and examined for hydrogen peroxide and ammonium nitrite.

In *Poggendorff's Annalen* for 1872 (p. 480), a summary is given of the results obtained by Pincus upon the formation of ozone, when thoroughly purified hydrogen gas was burned in atmospheric air. The gas was burnt with the smallest possible lens-shaped flame from a metal jet. According to Pincus, when a cold and clean beaker glass was held over the flame the contents of the beaker possessed as powerful an odour of ozone as the interior of a charged Leyden jar. When pure oxygen was substituted for the atmospheric air in a properly constructed apparatus, the same phenomena occurred, showing that the nitrogen of the air was not essential to its development.

The merit of having established, by rigorous experimental proof, the formation of ammonium nitrite by the burning of hydrogen thoroughly purified in thoroughly purified air, is due to Zoeller and Grete.† In their apparatus the air and hydrogen were purified by passage through potassium permanganate, potash, sulphuric acid, and Nessler's reagent, and the absence of both nitrous acid and ammonia in the gases prior to combustion most carefully demonstrated. The hydrogen was burnt in a jet 3 to 4 m.m. high issuing from a platinum blowpipe tip. The ammonia formed by combustion was converted into ammonio-platinum chloride, the nitrous acid was identified by diamido-benzole and other tests. Nitric acid was sought for, but no reaction for it was obtained. The authors make no mention of either ozone or hydrogen peroxide.

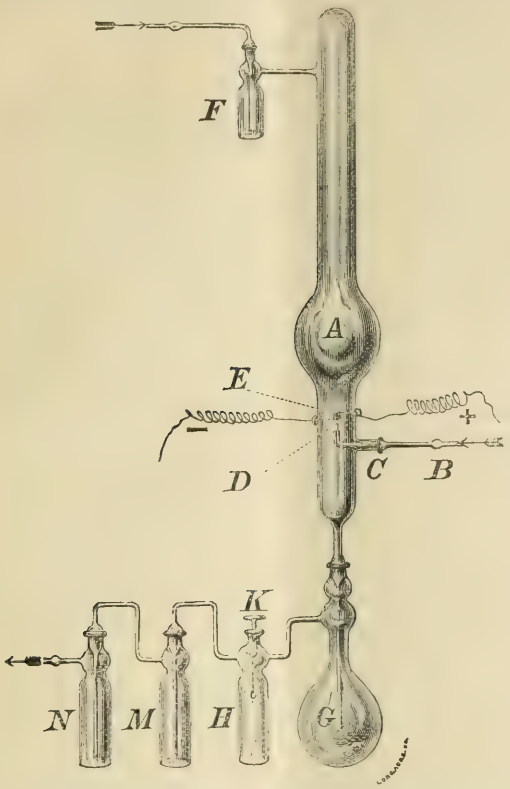
In entering upon the present investigation of this difficult topic, it was with the hope of constructing an apparatus in which, by the use of completely purified gases, and the elimination of all surfaces of contact with organic bodies, it would be possible to decide whether at one and the same time, ozone, hydrogen peroxide, and ammonium nitrite (and possible nitrate) were formed in process of combustion of hydrogenous substances.

The apparatus employed is figured in the accompanying cut. The combustion chamber A consists of a tall glass cylinder 80 c.m. in height and 6 c.m. in diameter, with a globular enlargement. At the bottom it connects, by a tube passing through a stopper of ground glass, with the receiving vessel, G. This vessel communicated with the bottle, H, whose stopper, K, is provided with a platinum hook fused in to its lowest part. H communicates with the wash-flasks, M and N, by tubes passing through their mouths and ground into them air-tight. The entrance tube, B, passes through the ground glass joint, C, and is fused to the platinum jet, D. Platinum wires connected with a coil are twisted into a very small spiral E, which is interrupted so as to allow of the passage of a spark immediately above the jet. At the upper portion of the chamber, A, there is a lateral tube connected with a wash-flask, F, which is provided with an entrance-tube passing through its stopper of ground glass.

* CHEMICAL NEWS, xxii, 13.
† *Wagner's Jahresb.*, 1874, p. 404; *Dingl. Polyt. Journ.*, ccxiii, 306
‡ CHEMICAL NEWS, xxii., 24.
|| *Chem. Centr.*, 1870, p. 161.
§ *J. pr. Chem.* [2] i., 415.

* *Zeitsch. Anal. Chem.*, x., 292.
† *Ber. Bericht.*, x., 2144.

In the performance of the experiments the air, after passage through a long tube filled with ignited asbestos, was passed through water, potassium permanganate, potash, sulphuric acid, and Nessler's reagent, entering at the upper end of the combustion chamber by the wash-flask, F. It encountered the hydrogen similarly purified at E, and combustion was brought about by passage of the spark at this point. The platinum spiral was made very small so as to be contained within the outer surface of the flame. This was done to obviate the possible error due to the contact of platinum at high temperatures with the mixed gases. At the same time some device of this character was necessary, since the perfectly purified hydrogen gave an invisible flame and it could not be certainly known, except by the incandescence of the platinum, whether the flame had gone out or not. Without the platinum, extinction of the flame was very apt to occur, but with the platinum this never happened. The products



of combustion flowed down into G, in which vessel and in H and M they were entirely condensed, these vessels being kept cold by ice. N contained a solution of potassium iodide, free from iodate and other impurities.

On opening the apparatus, in none of the trials was the odour of ozone noted. The potassium iodide alone, or after addition of starch water, was never effected when pure hydrogen was burned. When illuminating gas was used, the potassium iodide solution gave no indications of decomposition by ozone on application of tests. If starch was added to it, a faint reddish precipitate was formed. On filtering off this precipitate, washing thoroughly with water, and allowing it to remain in contact with air, it became violet in colour. Unfortunately the amount was so small that the nature of this yellow precipitate could not be determined with certainty. Aldehyd, passed into a solution of potassium iodide starch, yielded a yellow precipitate, turning first violet and then blue on exposure to air. But these experiments are apart from the main purpose of the investigation and the deportment of potassium iodide alone or with starch sufficiently established the fact that no ozone passed through the wash bottle, N.

The condensed water gave an intense reaction with the Griess's tests. When pure hydrogen was used the percentage of nitrous acid was 0·005 part in 100,000, that of ammonia 0·002 part per 100,000. These quantities are in the proportion corresponding to ammonium nitrite. The amount of hydrogen peroxide much exceeded that of ammonium nitrite, being 17 parts per 100,000. The various tests for hydrogen peroxide in which potassium iodide enters as one of the constituents were not relied upon as conclusive, since the results obtained might have been due to other substances possibly present. But the condensed water gave in addition an intense blue colour with fresh cold extract of malt and fresh guaiacum tincture. Moreover, it developed with solution of chromic acid a strong blue colour, the last being regarded as the most satisfactory of the tests applied to prove qualitatively the presence of hydrogen peroxide. No nitric acid was detected.

The amounts of nitrous acid, ammonia, and hydrogen peroxide obtained when purified illuminating gas was burned, were not determined, but the qualitative tests applied to establish their presence were the same as those used in the case of pure hydrogen and were equally satisfactory.

It should be observed that an apparatus of the character described is not well adapted to settle the question of the possible formation of ozone. The products of the combustion could not be rapidly withdrawn from the influence of the elevated temperatures in the immediate vicinity of the flame, and any ozone formed could readily have undergone decomposition. The experiment is a failure, in so far as its bearing upon the validity of the observations made by preceding observers is concerned. In all their experiments the immediate withdrawal of the products of combustion is an essential feature. In repeating their experiments, if other evidence than that afforded by the powerful odour of ozone is sought for, it would be necessary to obtain the absorption spectrum of ozone and the blackening of silver. Under the conditions of the experiment, other qualitative tests for the presence of ozone would be open to question. The amount of ozone necessary to yield these decisive proofs, however, is much greater than that which could possibly be obtained in any trial where all the essential precautions are observed. For these reasons further experiments are abandoned.

The final conclusion reached is the *certain formation* of hydrogen peroxide and ammonium nitrite, and, in view of the fact that the statements of others concerning the presence of ozone have not been disproven, the *possible formation* of ozone.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

BISMUTH.

EARLY in the century the combining weight of bismuth was approximately fixed through the experiments of Lagerhjelm.† Effecting the direct union of bismuth and sulphur, he found that ten parts of the metal yield the following quantities of trisulphide:—

12·2520
12·2065
12·2230
12·2465

Mean 12·2320

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Annals of Philosophy*, 4, 358. 1814. Results adopted by Berzelius.

Hence B=215 in round numbers, a value now known to be much too high. Lagerhjelm also oxidised bismuth with nitric acid, and, after ignition, weighed the trioxide thus formed. Ten parts of metal gave the following quantities of Bi_2O_3:—

11·1382
11·1275

Mean 11·13285

Hence, if O=16, Bi=211·85, a figure still too high.

In 1851 the subject of the atomic weight of bismuth was taken up by Schneider,* who, like Lagerhjelm, studied the oxidation of the metal with nitric acid. The work was executed with a variety of experimental refinements, by means of which every error due to possible loss of material was carefully avoided. For full details the original paper must be consulted; there is only room in these pages for the actual results, as follows. The figures represent the percentages of Bi in Bi_2O_3:—

89·652
89·682
89·644
89·634
89·656
89·666
89·655
89·653

Mean 89·6552 ± 0·0034

Hence Bi=207·523 ± 0·082; or, if O=16, Bi=208·001.

Finally, we come to the results obtained by Dumas.† Bismuth trichloride was prepared by the action of dry chlorine upon bismuth, and repeatedly rectified by distillation over bismuth powder. The product was weighed in a closed tube, dissolved in water, and precipitated with sodium carbonate. In the filtrate, after strongly acidulating with nitric acid, the chlorine was precipitated by a known amount of silver. The figures in the third column show the quantities of $BiCl_3$ proportional to 100 parts of silver:—

3·506 grms.	$BiCl_3$	3·545 grms.	Ag.	98·900
1·149	,,	1·168	,,	98·373
1·5965	,,	1·629	,,	98·005
2·1767	,,	2·225	,,	97·829
3·081	,,	3·144	,,	97·996
2·4158	,,	2·470	,,	97·806
1·7107	,,	1·752	,,	97·643
3·523	,,	3·6055	,,	97·712
5·241	,,	5·361	,,	97·762

Mean 98·003 ± 0·090

Hence Bi=210·464 ± 0·294.

The first three of the foregoing series of experiments were made with slightly discoloured material, and may therefore be rejected. The remaining six percentages give a mean of 97·791; whence Bi=209 78; or, if O=16, Bi=210·26.

As between the unaccordant results of Schneider and of Dumas, those of the former chemist are probably nearest correct. His method of determination was the more reliable, and the details which he gives concerning his manipulations afford strong presumptions of accuracy. Doubtless the bismuth trichloride used by Dumas contained, like the corresponding antimony compounds, traces of oxychloride. We may fairly assume, for all practical purposes, that the atomic weight of bismuth cannot be far from 208.

The following additional note has been communicated by the author:—

* *Poggend. Annal.*, 82, 303. 1851.
† *Ann. d. Chim. et de Phys.*, (3), 55, 176. 1859.

Since this chapter was written, the lower value for bismuth has been confirmed by Marignac.* First, Bi_2O_3 was reduced in hydrogen; yielding, in mean of six experiments, 10·318 ± 0·0035 per cent of oxygen. Hence, if O=16, Bi=208·60. Secondly, Bi_2O_3 was converted into $Bi_2(SO_4)_3$. In six experiments, in mean, 100 parts of oxide yield 151·728 ± 0·0099 of sulphate. If S=32·06, Bi=208·16.

Using the new values for O and S found in this recalculation, Marignac's results compute as follows:—

Oxide series .. .. Bi=208·125 ± 0·085
Sulphate ,, ... ,, 207·672 0·064

These values, combined with that deduced from Schneider's work, give, in mean, Bi=207·743 ± 0·043. If O=16, this becomes Bi=208·221

Two experiments have also been published by Lowe,† who oxidised bismuth with nitric acid. His results give a mean of 10·352 per cent of oxygen in Bi_2O_3, whence, if O=15·9633, Bi=207·362.

TIN.

STANNIC oxide and stannic chloride are the compounds which have been studied in estimating the atomic weight of tin.

The composition of stannic oxide has been fixed in two ways; by synthesis from the metal, and by reduction in hydrogen. For the first method we may consider the work of Berzelius, Mulder and Vlaanderen, and Dumas.

Berzelius‡ oxidised 100 parts of tin by nitric acid, and found that 127·2 parts of SnO_2 were formed.

The work done by Mulder and Vlaanderen‖ was done in connection with a long investigation into the composition of Banca tin, which was found to be almost absolutely pure. For the atomic weight determinations, however, really pure tin was taken, prepared from pure tin oxide. This metal was oxidised by nitric acid, with the following results. 100 parts of tin gave of SnO_2:—

127·56—Mulder.
127·56—Vlaanderen.
127·43— ,,

Mean 127·517 ± 0·029

Dumas§ oxidised pure tin by nitric acid in a flask of glass. The resulting SnO_2 was strongly ignited, first in the flask, and afterwards in platinum. His weighings, reduced to the foregoing standard, give for dioxide from 100 parts of tin the amounts stated in the third column:—

12·443 grms. Sn	gave	15·820 SnO_2.	127·14
15·976 ,,		20·301 ,,	127·07

Mean 127·105 ± 0·024

In an investigation later than that previously cited, Vlaanderen¶ found that when tin was oxidised in glass or porcelain vessels, and the resulting oxide ignited in them, traces of nitric acid were retained. When, on the other hand, the oxide was strongly heated in platinum, the latter was perceptibly attacked, so much so as to render the results uncertain. He therefore, in order to fix the atomic weight of tin, reduced the oxide by heating it in a porcelain boat in a stream of hydrogen. Two experiments gave Sn=118·08, and Sn=118·24. These, when O=16, become, if reduced to the above common standard,

127·100
127·064

Mean 127·082 ± 0·012

* *Arch. des Sci. Phys. et Nat.* (3), 10, 10. 1883.
† *Zeit. Anal. Chem.*, 22, 498.
‡ *Poggend. Annal*, 8, 177.
‖ *Journ. f. Prakt. Chem.*, 49, 35. 1849.
§ *Ann. Chem Pharm.*, 113, 26.
¶ *Jahresbericht*, 1858, 183.

We have now four series of results showing the quantity of SnO_2 formed from 100 parts of tin. To Berzelius's single value may be assigned the probable error of a single experiment in Mulder and Vlaanderen's series :—

Berzelius	127·200 ± 0·041	—Oxidation.
Mulder and Vlaanderen ..	127·517	0·029— ,,
Dumas	127·105	0·024— ,,
Vlaanderen	127·082	0·012—Reduction.
General mean ..	127·143	0·0098

Dumas, in the paper previously quoted, also gives the results of some experiments with stannic chloride, $SnCl_4$. This was titrated with a solution containing a known weight of silver. From the weighings given 100 parts of silver correspond to the quantities of $SnCl_4$ named in the third column :—

1·839 grms.	$SnCl_4$ = 3·054 grms. Ag.	60·216
2·665 ,,	4·427 ,,	60·199
	Mean	60·207 ± 0·006

All these data properly combined give us the following values for the atomic weight of tin :—

From SnO_2	Sn = 117·624 ±	0·050
,, $SnCl_4$	,, 117·832	0·067
General mean ..	,, 117·698	0·040

If O = 16, this becomes Sn = 117·968.

THE SPECTROSCOPIC EXAMINATION OF THE VAPOURS EVOLVED ON HEATING IRON, &c., AT ATMOSPHERIC PRESSURE.*

By JOHN PARRY, Ebbw Vale.

METALLURGISTS favoured with opportunities of observing the behaviour of metals whilst being heated or fused are of opinion that the fumes usually seen are due to the volatilisation of the metal itself or of some more volatile constituent.

In casting alloys of the more fusible metals this dissociation or volatilisation is an accepted fact, and is usually considered when adjusting the proportions of the constituents. Alloys of the more infusible metals, such as iron, manganese, nickel, cobalt, &c., have not been studied; but those who have observed the behaviour of crude iron and steel whilst being fused, or otherwise manipulated at high temperatures, have noted that, in addition to the well-known evolution of gas, fumes are given off, which has led to the inference that, as before stated, some more volatile constituent is being evolved; and Professor Ledebur asserts that as iron is being volatilised, the chemical composition of the metal may be changed, presumably, within certain narrow limits. It may be that crude iron is slowly dissociated, and certainly at the high temperature of the Bessemer process iron is volatilised, and may be seen far above the mouth of the converter, forming a red cloud, quite unlike ordinary smoke or vapour.

The spectroscopic examination of the flames issuing from blast and other furnaces show only continuous spectra, with but few lines, very similar to the spectrum of the ordinary Bunsen flame, with the exception of the Bessemer flame, which gives the carbon spectrum, together with (according to some observers) that of manganese.

I have, however, found that many of the metals are volatilised at a comparatively low temperature, but give only continuous spectra when examined in the flame. The vapour requires the intense heat of the electric spark to be passed through it to ensure complete dissociation, and consequent production of the usual line spectra. (A list of metals tested is attached hereto).

Spiegeleisen fused in a crucible evolved a fume in which I detected zinc, copper, manganese, calcium, and, with less certainty, magnesium.

Bessemer pig iron, similarly treated, gave copper, manganese, calcium, either lead or arsenic, as well as gas burning with a flame resembling that of carbonic oxide.

Bessemer pig iron burnt in a stream of oxygen at a dull red heat gave copper, manganese, &c., as before, but more intensely; also a great number of lines which appear to be derived from iron. This spectrum requires careful study, and, when developed, may throw some light on the reactions occurring during the Bessemer blow.

Spanish iron ore reduced in a crucible with charcoal, at a heat sufficient to form a button of fused metal, evolved zinc, copper, and manganese.

It is therefore probable that matter may be evolved during the ordinary heating processes in the manufacture of iron and steel, as previously explained, but giving no visible indications of the fact, in consequence of the heat being sufficient only to volatilise without effecting dissociation.

With my present limited experience, I am of opinion that the actual quantity of matter evolved from iron, steel, &c., is very small, and not at all likely to affect the quality of the coarser kinds of iron and steel, although it may be otherwise when a material of good quality and great purity is required.

The germ of the foregoing is to be found in the recent work of spectroscopists, more especially of Mr. Lockyer, who, in his "Studies in Spectrum Analysis"—a volume abounding in suggestions which should, in my opinion, be carefully studied by those practically engaged in the iron manufacture—says, "Depend upon it, that as spectroscopy becomes the daily work of ironfounders and the like, it will be found to be bristling with scientific truth which may be used in these practical applications."

Note.—Spanish iron ore evaporated to dryness with hydrocholoric acid. The dried chlorides were carefully and gradually heated in the blowpipe, and copper, zinc, calcium, barium, lead, silver, and manganese lines successively detected in volatilised chlorides. At the highest obtainable heat iron lines are seen.

The impure ferric chlorides, obtained by digesting steel or iron in hydrochloric acid and evaporating to dryness, heated as above, shows—1st, copper and calcium; 2nd, manganese; next, with less certainty, chromium and magnesium. On increasing the heat, the iron spectrum is vividly seen.

Steel or iron filings, mixed with ammonium chloride, and heated also, gives the foregoing series of spectra, which last longer, and may be repeated by successive additions of the chloride.

Very fine spectra of sulphur and phosphorus may be obtained by slightly heating either, on a moderately hot plate of iron, placed just below the spark from the coil.

Notes on the Volatility of the Metals Heated in Crucibles. Fletcher's "Injector Blowpipe" used.

Thallium ..	Very volatile. Seen in flame and spark above.
Arsenic ..	Do. Seen in spark only.
Copper ..	Do. Volatilised from most metals, in flame and spark.
Cadmium ..	Easily volatilised. Seen in spark only.
Zinc	Do. Do.
Bismuth ..	Volatilised at highest red heat. Do.
Aotimony ..	Easily volatilised. Do.
Potassium ..	Do. In flame and spark.
Sodium ..	Do. Do.
Tin	Volatilised at highest temperature of blowpipe. Spark only.
Lead	Volatilised at lower temperature than tin. Spark only.

* Continuation of previous researches on the Vapours Evolved from Iron, Steel, &c., Heated *in vacuo*.

Silver	Not volatile. Spark only.	Copper spectrum seen.
Gold	Not volatile. Spark only.	Copper spectrum seen.
Chromium ..	Not volatile. Spark only.	Copper spectrum seen.
Manganese..	Volatilised with difficulty.	Spark only.
Aluminium..	Volatile.	
Selenium ..	Very volatile. Spectra require further study.	
Tellurium ..	Do.	Do.
Phosphorus..	Easily volatilised on hot plate. Good spark spectrum.	
Sulphur ..	Do.	Do.

Notes of Experiments on the Spark Spectra of the Chlorides of the Metals and Alkalies Volatilised at Atmospheric Pressure.

The chlorides of lithium, strontium, copper, and calcium are volatile in the flame of an ordinary alcohol lamp, showing the characteristic spectral lines in the spark about one inch above the flame.

Zinc, barium, copper, and magnesium chlorides are also faintly seen. Query about arsenic? Filter-paper moistened with zinc chloride and placed in the alcoholic flame gave the line W. L. 4809.

Steel filings, mixed with ammonium chloride and heated —copper and manganese first appear, next calcium, (zinc ?), next iron spectra; after heating thirty minutes only on copper and manganese two lines are seen. Iron lines nearly gone; calcium seen. Further heated thirty minutes, only calcium; traces of copper flashing out.

Spiegeleisen as above; in addition, magnesium seen; brighter spectrum throughout.

Copper chloride mixed with ammonium chloride and heated with spirit-lamp in a glass tube 20 inches long—copper distinctly seen in the spark at the top of the tube.

Impure steel chlorides, as above, heated in glass tube 4 inches long, spark at top—calcium first seen, copper, next manganese group. After heating some time, only calcium and copper were visible.

Ordinary nickel, cobalt, bismuth, tin, and antimony show copper spectrum when heated. All metals hitherto tested evolve copper.

Query zinc in steel?

Qunry magnesium in spiegel? Only first line of magnesium seen on edge of nitrogen line, W. L. 5712.

Compared this line with magnesium, by clamping cross wires down on it; magnesium line distinctly seen on edge of nitrogen, W. L. 5712.

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

May 24th, 1884.

Prof. F. GUTHRIE, President, in the Chair.

NEW member:—Mr. F. C. Phillips, electric engineer.

Prof. W. G. ADAMS took the chair, while the President, Dr. GUTHRIE, gave a brief summary of his "*Recent Researches on Eutectic Alloys*," that is, alloys of low fusing point. The complete research will be published in the Society's *Proceedings*. Dr. Guthrie showed by means of tables and curves of results that mixtures of water and nitre, nitre and nitrates, &c., behaved in the same way as fusible alloys, such as alloys of lead and bismuth. On cooling down the alloy or mixture the ingredient present in richer quantity crystallised out. There seemed to be no definite molecular proportions in these alloys. A "tetra-entectic" alloy of bismuth, 47·38; tin, 19·97; lead, 19·36; cadmium, 13·29 per cent, was exhibited by the author, which fused at 71°, or in boiling alcohol. Rose's fusible metal melts at 93°. Results were given of the behaviour of mixtures of water and the aniline salts, salicylate, oxalate, &c.; also of water and triethylamine, and other members of the ammonia group. Dr. Guthrie's observations tended to show that fusion and solution were of the same nature. He pointed out their bearing on mineralogy and geology, and inferred that water in igneous rocks was there from the first, and not by infiltration as some suppose.

The PRESIDENT then took the chair, and Dr. W. H. STONE exhibited a simple, cheap, and profitable Galvanometer for Hospital Use, made of a boxwood cylinder with coils wound round it, and a needle with mirror inserted into a test-tube, and pushed into the hollow of the cylinder. The needle is made dead beat by putting paraffin oil into the tube. He also exhibited a Kohlrausch Metre Bridge for Alternating Currents, a telephone playing the part of indicator. Dr. Stone employs it for measuring the resistance of the human body, which he finds to be less than 1000 ohms. With high tension currents it appears lower than with low tension currents. Another Metre Bridge of the kind with a longer wire (3 metres in this case as compared with 14 metres in the other) was also shown in connection with a sledge induction coil, by which the power of the current can be regulated to suit the patient. Dr. Stone stated that the body acts more like a solid than a liquid conductor.

Mr. GLAZEBROOK said he had used a similar plan, with telephone, to measure the resistance of electrolytes, but found the telephone too sensitive from induction, though in Dr. Stone's work this objection might not apply.

Prof. G. FORBES stated that the telephone had been applied in a similar way to comparing capacities.

With regard to the danger from currents, Prof. AYRTON said the electromotive force of the railway current at Bushmills was 250 volts, and pointed out that very intermittent currents were more dangerous than fairly continuous ones.

Dr. STONE thought that with good skin contact (as with salt and water) this electromotive force would be dangerous.

Mr. LECKY instanced the reported death of a horse at Bushmills by a shock.

A new Speed Indicator, especially for Marine Engines, was exhibited by Mr. W. T. GOOLDEN and Sir A. CAMPBELL, of Blythswood. Its action depended on the rolling of a disk on a cone; the disk traversing a screw driven by the engine shaft. The disk forms the nut of the screw and rotates in an opposite direction to the latter. Its position on the screw depends on the surface velocity of the cone, which is kept turning at a uniform rate by clockwork. In travelling, the disk makes a series of electric contacts, which indicate its position on a set of dials detached. Recording apparatus can be added. The apparatus was made by Mr. A. Hilger.

Mr. W. BAILEY exhibited a similar device in which the cone was replaced by a circular plane or disk. He had invented this independently, and it had the advantage of giving a zero position to the rolling disk, though the cone was the more compact arrangement. The idea of using a screw in this manner was suggessed by Mr. Shaw, of Bristol, some three years ago.

The Substitution-Values of the Principal Organic Nutrients in the Animal Body.—Dr. Max Rübner.—The diet of any animal must afford one nutrient, *i.e.*, albumen, in a certain quantity; otherwise substitutions may take place within a very wide range. The author concludes that the fat in food is in equal weights isodynamic with the fat of the body. Muscular flesh consumed is for equal weights isodynamic with the albumenoid matter which is lost by the body in case of an insufficient supply. Fats and carbohydrates differ in their efficacy very widely, 100 parts of fat representing 240 parts of carbohydrates.—*Biedermann's Central-blatt für Agrikultur Chemie.*

NOTICES OF BOOKS.

The Cinchona Barks: Pharmacognostically considered. By F. A. Fluckiger, Ph.D., Professor in the University of Strassburg. Translated from the original text, with some explanatory notes by F. B. Power, Ph.D., Professor of Pharmacy and Materia Medica in the University of Wisconsin. London: J. and A. Churchill.

We have here an elaborate monograph of the trees yielding quinine and its kindred alkaloids. The author's point of view, strictly speaking, is neither that of the chemist nor of the botanist, but that of the pharmacologist. It is to be regretted, considering his high and well-merited authority, that he still sanctions the erroneous orthography "cinchona" instead of "chinchona," and doubtless the pronunciation as if the word were of Greek origin. It is a proof how little a prophetess may be honoured in her own country that the name of the Countess Chinchon can scarcely be recognised in "quinas," the Spanish term for the chinchonas. It is, however, needless to dwell on a subject which has been so ably, but, we fear, so fruitlessly discussed by Mr. C. Markham.

In the treatise before us Professor Flückiger considers firstly the botanical origin of the barks, defining them as those "containing alkaloids of a particular group, which may directly be denoted as the cinchona bases," and met with hitherto only in the barks of the *Cinchoneæ*. He notices the fact that the *Cinchona cuprea* belongs morphologically to the false, but chemically to the true barks, and conjectures that other useful barks of this class may be detected in the genera *Cascarilla*, *Remijia*, and *Pimentelia*.

In the next section follows an account of the characteristics of the most valuable species and their geographical distribution. As regards their conditions of growth the Cinchonas are somewhat peculiar. They are naturally confined to the Cordilleras, and are absent in other parts of South America which apparently afford the same physical conditions, and which are inhabited by other *Cinchoneæ*. Their range is from 10° N. to 22° S latitude, and their favourite mean temperature from 12° to 20° C. Frequent showers and mists, mingled with bright sunshine, and frequent, but not wide, changes of temperature, appear essential. Their range in altitude is from 2275 to 9425 feet—which region they indeed characterise. The attempts at the artificial cultivation of the Cinchonas in India, Ceylon, Java, Jamaica, &c., are described, and their success is fully acknowledged. The suggestion is thrown out that the so-called *Cinchona cuprea*, and probably other species belonging to the genus *Remijia*, might be successfully cultivated in hotter and drier regions. A succeeding chapter describes the collection of the wild barks in their native forests—a laborious, perilous, and not very remunerative undertaking—and the rival processes of "mossing" and "coppicing," under trial in India and Java. In the former method, invented by the late lamented Mac Iver, vertical strips of the bark are removed, about 1½ inch in width, and then covering the stem with moss, clay, or, as in Java, the Alang-alang grass (*Imperata Konigii*). It is generally maintained that the bark renews itself quickly on the denuded portions, and is richer in alkaloids than before. Prof. Flückiger, however, raises the question whether this process can be carried on for a series of years without affecting the strength of the trees? The question may also be raised whether the moss, &c., will not afford a safe *nidus* for destructive insects. In Java Moens has introduced a process of merely scraping the bark in place of entire removal. In the coppicing system, widely practised in Java and Ceylon, the stems at 8 years of age are felled at the height of 6 inches from the ground. The side shoots produced in another eight years are said to furnish a bark equally rich. The bark of the roots, formerly wasted, are found to abound in alkaloids.

Passing over the very elaborate accounts of the morphological structure of the cinchona barks, the localisation of the alkaloids in the tissues and the description of the principal commercial varieties of true and false barks, we come to the statistics of the trade. It appears that upwards of 6 million kilos. of bark are yearly brought into the market. As the average value per kilo. is 4s. to 5s., the annual cinchona harvest is worth £1,500,000 sterling.

The chemical composition of the barks is elaborately dealt with. They contain the following bases in noteworthy proportions:—Quinine, quinidine, cinchonine, cinchonidine, and in smaller amounts homo-cinchonidine, cinchonamine, homoquinine, quinamine, conquinamine, and cinchamidine. Other bases present, but differing widely in their properties, are aricine, cusconine, cusconidine, cuscamine, cuscamidine, paytine, and paricine. There are further certain amorphous bases, as yet very imperfectly known, and perhaps formed from the crystalline alkaloids during the process of manufacture.

The total quantity of alkaloids—as is proved by analytical results here given—is open to very considerable fluctuation even in the same species. De Vrij found in the bark of *Cinchona officinalis* from Ootacamund proportions of quinine ranging from 1·25 to 9·1 per cent.

As a means of detecting the presence of quinine and cinchonine in vegetable matter Grahe's process is recommended. The bark is heated with a volatile acid, organic or inorganic, when a beautiful red decomposition product is formed. Hesse has further improved upon this test by first extracting the bark to be tested with alcohol, drying up the tincture with an appropriate quantity of the powder of the same bark, and then heating as above.

For the quantitative determination of the total alkaloids and of the quinine, the methods of Squibb and of De Vrij are given in full.

The sixteenth and seventeenth chapters give the history of the barks, or rather of our knowledge of them. Curiously enough it is by no means certain whether the medicinal properties of the bark were known to the Aborigines prior to the Spanish invasion or whether they were a subsequent discovery. Humboldt notes the fact that the native Peruvians do not employ the cinchona, and even regard it with aversion, and Markham mentions that it is not employed by the native itinerant doctors. This very valuable work is illustrated with eight plates, six of which represent the species *C. succirubra*, *C. Calisaya*, *C. lancifolia*, *C. officinalis* and *Remijia pedunculata*. Plates VII. and VIII. represent transverse sections of the barks of *C. Calisaya*, *C. lancifolia*, and *C. cuprea*.

The treatise is further enriched with a very complete bibliography.

We regret that in a work emanating from a London firm of publishers of good standing a foreign orthography should have been sanctioned, and that there occur a few expressions which cannot be considered as idiomatic English.

Numerical Exercises in Chemistry. By T. Hands, M.A. F.R.A.S. London: Sampson Low, Marston, Searle, and Rivington.

This little work is one of a class which is now increasing in number. In successive chapters the author gives examples illustrative of the metric system of weights and measures, of thermometric scales, of volume, mass, density, and weight, of Boyle's law and Dalton's law of gaseous mixtures, of Gay-Lussac's law, of Graham's law of gaseous diffusion, of specific heat, latent heat, chemical equations, water, nitrogen and air, the crith, and of heat as a form of energy. Finally, come a number of miscellaneous examples, a list of elements, or at least of some of them, a set of equations representing the reactions indicated in the foregoing examples; certain tables furnishing additional exercises on the gases and answers to all the examples.

The value of this book, and of certain other works of the same type which have from time to time been noticed in our columns, depends exclusively upon the use to which

they are put. If they are employed as an adjunct to a sound laboratory training they will prove exceedingly serviceable and must command our hearty approval. If, on the contrary, they are used as substitutes for the experimental study of the science they are useless, if not positively hurtful. Useless they may be held in such case because they do not in the least contribute to cultivate the powers of observation and of drawing right conclusions from facts, which, setting all utilities and practical applications aside, are the educational advantages to be derived from a study of chemistry, or, indeed, from that of any other branch of physical science.

We must hope, however, that the book before us may be put to its legitimate uses, which are by no means trifling. It is a good omen that in it we find no reference to preparation for any examination, and no attempt to new chemistry with reference to somebody's "syllabus."

Workshop Receipts. (Third Series). By C. G. Warnford Lock. London: E. and F. M. Spon.

This volume deals principally with metallurgical and electrical subjects. The method of Webster for the improved production of aluminium is given, and whilst the valuable properties of the pure metal and of certain of its alloys are fully admitted, the extent of the economy effected by the new process is called in question, in accordance with the calculations of Mr. Weldon. He contends that Webster's improvements relate merely to obtaining anhydrous alumina from potash-alum. If his method of effecting this object were 50 per cent cheaper than that followed by Pechiney, at Salindres, it would not reduce the cost of metallic aluminium by more than 5 per cent. We believe, however, that Mr. Webster takes his stand not on the lower price but on the superior quality of the metal obtained by his method.

Mr. Weldon shows, on thermo-chemical principle, that the reduction of alumina by carbon cannot be regarded as practicable.

Under the head "Lubricants" we find a timely and judicious exposure of a common error. It is commonly supposed that the ordinary vegetable and animal oils, because they are incapable of burning without a wick, unless heated to very high temperatures, are, therefore, under all circumstances, safer than the the mineral oils. Yet both chemical theory and experience—often of a very sad nature—prove that such is not the case. A few drops of olive-oil spilt upon cotton-waste, saw-dust, &c., and thus spread out over a large surface, occasion a rise of temperature which often reaches the point of ignition. Mineral oils, even such as have a very low "flashing-point," produce no similar phenomenon, and are consequently safe, except brought in contact with a flame.

A considerable number of formulæ out of "some hundreds, if not thousands, propounded," are here quoted. One of them we notice for its singularity:—"Maguire uses for hot-neck grease tallow, 16 lbs.; fish, 60 lbs.; soapstone, 12 lbs.; graphite, 9 lbs.; saltpetre, 2 lbs. The fish (whole) is steamed, macerated, and the jelly pressed through fine sieves for use with the other constituents."

A caution is given concerning the use of mineral oils as lubricants in print-works, &c. Unless unusual care is taken they are often dropped upon the cloth and are frequently hard to remove, since they are not saponified by alkalies as are the animal and vegetable oils and fats. Mention is made of the corrosive action of the paraffin oils upon lead and zinc, whilst they do not affect tin, copper, and iron.

The utilisation of blast-furnace slag is considered at some length. One of the most plausible suggestions—its utilisation for building purposes—must be viewed with disfavour on account of the fact that the blocks are impervious to air. Hence a house built of slag will be always damp and its ventilation will be defective. Those slags which contain a tolerable proportion of phosphoric acid are now often utilised as manure, *e.g.* under Thomas and Twynam's patent. Indeed, if man could afford to wait for the slow natural process of decomposition, weathered slags, like old lavas, would form exceedingly fruitful soils.

The slag of the Creusot works is found to contain 1·92 per cent of vanadic acid, and as treated by Witz and Osmond is now one of the chief sources of vanadium compounds for use in the production of aniline blacks, &c.

It is not generally known that broken iron slags often found their way at one time into bone-ash and ground bones. If such samples were analysed by the rough and ready process of dissolving in hydrochloric acid and precipitating with ammonia, the precipitate being taken as tricalcic phosphate, this fraud was not detected.

Slag-wool, if moistened, is shown to be valueless as a non-conductor of heat, and if sulphur is present positively dangerous.

The utilisation of scrap-tin is here discussed. Many of the methods proposed are pronounced too expensive, but a favourable opinion is given of Reid's process. He oxidises the film of tin and the alloy of tin and iron immediately beneath by roasting in a specially constructed furnace, and shakes off the dust of oxides by machinery, leaving the iron in a pure state. The powder is treated with hot sulphuric acid, which dissolves the iron leaving the stannic oxide untouched. The iron sulphate is evaporated down and distilled to recover the sulphuric acid, whilst oxide of iron is left behind and is utilised as a pigment. The tin left as oxide may be smelted in the usual manner, or it might be treated with caustic soda and thus converted into preparing-salt. The waste heat from the retorts is used to assist in roasting the scraps and in evaporating down the iron sulphate.

Whilst wishing this process success we fear that it will in most cases be complicated by the presence of lead, with which the tin used in tinning iron is now largely sophisticated.

This work throughout will be a very useful manual for amateur experimentalists—now a very numerous class—and will preserve them from many tedious and costly mistakes.

The Patents, Designs, and Trade Marks Act, 1883: with Introductory Chapter, Explanatory Notes, Notes of Decided Cases; also the Practice for Obtaining Letters Patent for Inventions and the Registration of Designs and Trade Marks, with Rules, Schedules of Fees, Forms, Tables, a Complete General Index, &c. By Roger W. Wallace, Barrister-at-Law. London: W. Maxwell and Son.

The new Patent Act has of course to a considerable extent unsettled the minds of inventors and patent agents. Time must elapse before the provisions of the new system can become as familiar to persons interested as were those of the old law. Such a work as the present is, therefore, well timed and will doubtless prove of no small service. It must be borne in mind that the right interpretation of any Act of Parliament is a special art which outsiders can rarely attempt with success. The present Act has furnished an instance in point. As all the former statutes bearing on letters patent for inventions were repealed, and as in last year's Act there was no clause legalising "communications from abroad," it was very generally supposed that such "communications" were done away with. But it soon appeared that this interpretation was erroneous. The Comptroller-General of Patents—whether in accordance with or in evasion of the Act we are not qualified to decide—drew up a new form for such "communications," and they are now going on precisely as they did before. Why alien inventors should prefer this procedure to taking out directly a British patent in their own names is a mystery.

Mr. Wallace makes it his object simply to expound the law as it is, without, in general, throwing out any suggestions as to what it should be. In connection with the duties of the newly-appointed examiners he refers to one point which "must very shortly be the subject of judicial de-

cision," namely, "whether the nature of the invention has been fairly described." Concerning this same preliminary examination we are by no means satisfied. As it does not extend to the novelty of the invention there is at least room to doubt whether it can benefit either the inventor or the public. It certainly will not, as some persons have imagined, enable the inventor to dispense with the trouble of a search.

Notice is taken of the change that an English patent does not henceforth, as formerly, lapse with the expiry of any prior foreign patent for the same invention. We look, however, in vain for any explanation of the reasons which may have induced the Legislature to make this singular and apparently gratuitous alteration.

The author does not consider that an inventor has any natural property in his invention, and hence bases patent-right merely on the ground of public expediency.

The following principle is, in our humble opinion, much to be regretted:—"When letters patent have been obtained for a *new result* and the patent describes a process of arriving at that result which is effectual at the date of the patent, the patentee is entitled to protection against all other processes: it is an infringement to adopt any other process for the purpose of arriving at that result." The German law, more wisely, protects merely the particular process or processes by which the patentee arrives at his result. The reason is palpable; some other person may, to-morrow or next year, invent a much better process for obtaining the same result. According to the English law this is infringement, and consequently the public may lose the benefit of a cheaper or a better article, whilst at the same time invention is repressed. Many competent authorities hold that this very feature of the English law is one great cause of our relative decline in the manufacture of the coal-tar colours. We trust that the attention of the legislature will, at no distant date, be called to this flaw in our patent system. Indeed, this point alone gives Mr. Macfie and his supporters a powerful argument against the existence of patent right altogether.

One useful modification which has been embodied in the Act of 1883 is the provision for compulsatory licenses, in case of an alien who holds a British patent and refuses to work it in this country whilst employing the same process elsewhere. Mr. Wallace considers this a valuable provision, but seems to doubt if it will be properly carried out. Surely a provision annulling the patent on refusal to work would have been the simpler and safer expedient.

Many defects have already been pointed out in the new law, and with the sole exception, perhaps, of the provision for compulsory licenses, it becomes somewhat doubtful whether the old system was not better.

One unhappy alteration in the *Patent Office Journal*, made not in consequence of the Act, but at the good will and pleasure of the Comptroller-General, is the omission of the foreign patent lists, which formerly constituted a valuable feature.

CORRESPONDENCE.

ENSILAGE.

To the Editor of the Chemical News.

SIR,—After carefully considering where Mr. Smetham and myself seem at variance, I have decided to leave those interested in the subject to decide between us on the various points, several of which seem to me matters of opinion. Moreover, to answer the criticisms satisfactorily, as I believe I could, would take a great deal of space, more indeed than the subject justifies.

My endeavour was to calculate the whole contents of the silo. Had I noticed, as I ought, that the silage stood 9 ft. deep, I would have taken the 2 ft. layer to represent all that lay above it, and multiplied by the necessary factor. I have since done this and the results confirm my original conclusion that there was no change of so-called indigestible fibre into digestible matter. The data were not all that could be wished, but they were the most accurate obtainable, and having made the calculations for myself I thought they might help others who are working at the subject of ensilage. The explanation of the mineral matter given by Mr. Smetham may be correct, but Mr. Smetham has overlooked the fact that the layer 2 ft. from the bottom has more mineral matter in it than the bottom layer of mixed drainage and silage. To eliminate this factor my calculations were made on the organic matter only.

I hold that it is useless to draw conclusions from the analysis of any single layer of silage in a silo. The whole bulk must be taken into the calculation, without which it is impossible to say what changes take place. Mr. Smetham's analyses and criticisms are valuable, for they show that there is no uniformity of composition in the contents of a silo, and that to obtain a definite sum total of constituents will be a very difficult and complicated work. Nevertheless, I do not think that I have underestimated the feeding value of silage, and believe, in spite of Mr. Smetham's criticisms of minutiæ, the conclusion that there is no change of indigestible fibre into digestible is based upon far more accurate data than the opposite conclusion that there is such a change.—Yours, &c.,

FREDK. JAS. LLOYD.

Agricultural Laboratory,
4, Lombard-court, E.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 14, April 7, 1884.

Determination of Phosphoric Acid in Arable Soils and Rocks.—Ad. Carnot.—(See p. 216.)

Artificial Production of Fayalite.—Alex. Gorgen.—Not suitable for abstraction.

Reclamation of Priority as regards the Vitality of Virus and of Beer Yeast.—M. Melsens.—The author shows that the recent memoirs of MM. R. Pictet and Yung, and of M. P. Regnard (*Comptes Rendus*, present volume, pp. 745 and 747), have been anticipated by his papers (*Comptes Rendus*. lxx., p. 629, and lxxi., p. 73).

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xiii., Part 2.

Examination of Certain Japanese Soils.—Dr. O. Kellner and H. Imai.—Niphon, the chief Japanese island, is by no means so fruitful as it has been supposed. The character of the indigenous vegetation, the method of manuring pursued by the natives, and their disinclination to break up new land, argue a certain poverty of the soil in available plant-food. This conclusion is supported by analytical research. Both the soils and sub-soils appear rich in ferric and ferrous salts, and poor in lime.

The Synthesis of Neutral Fat from Fatty Acids in the Animal System.—Immanuel Munk.—A dog fed on meat and fatty acids, obtained from mutton tallow, was found to have accumulated in his body neutral mutton tallow.

Manurial Experiments on Potatoes at the Danzig Experimental Station.—Prof. Maercker.—A dose of manure containing more than 8 kilos. nitrogen and 10 of phos-

phoric acid per "morgen" produced no appreciable result. Nitrogen as an ammoniacal salt, in conjunction with superphosphate, acted better, both as to quality and quantity, than when given in the form of soda-saltpetre. By the addition of large quantities of potash salts in spring, the injury to quality occasioned by soda-saltpetre, so far from being compensated, was even increased. Fœcal superphosphates had a distinctly better effect, both as to quantity and quality, than a mineral manuring. The experiments were conducted on a pure "dunes"-sand, almost devoid of plant-food. On a soil which had been cultivated, but which was very light, the yield was best where the proportion of nitrogen to soluble phosphoric acid was 7 : 9½. The more these proportions were departed from, so as to approach a purely phosphatic manuring, it was less completely utilised. A dressing with potash alone was so depressing that the yield was inferior to that of the unmanured check-plot.

Experiments on Potato-manures in Ireland.—Dr. C. A. Cameron.—From the *Field*.

White Mustard as Cattle-Food,—Dr. Brummer.—The author maintains that this plant does not injure the health of cows, and improves the quality of the butter.

On Feeding Cows with Corn and Bran.—Dr. M. Schrodt and Dr. Hansen.—Admissible only when the price of corn is low.

Researches on the Influence of Heat and Light on the Development of Plants.—Prof. Hellriegal.—The optimum temperature for the various physiological functions of plants ranges between 20° and 70°; heats above 50° are destructive to the more highly organised species. The most important part of the nutrition of plants—the decomposition of carbonic acid and the assimilation of carbon in the chlorophyll-cells—is purely a function of light. In a faint light the process of assimilation is sluggish; it increases with the intensity of light, and reaches an optimum, which, however, is not the maximum point. Heat and light, together with the rainfall, form the factor of fertility generally summed up under the terms *weather* and *climate*, and it is easily intelligible that in agricultural practice they are found to determine the crops more frequently and more decidedly than the soil and the manures.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., December, 1883.

This number is chiefly taken up with the awards of prizes.

January, 1884.

Report presented by M. Jungfleisch on behalf of the Committee of Chemical Arts on a Process for the Preservation of Raw Meat, Game, and Fish for a Time not less than a Month.—The process in question, that of MM. Mignon and Rouart, depends on the application of cold. The meat in question is suddenly refrigerated to about −20°. This feature, which is of course the only novel point in the process, is to prevent the escape of fluid matters during a slow refrigeration.

February, 1884.

Manufacture of Gas from Various Residues of Distillation, Oils of Schists, &c.; Carburetted Air.—M. Felix le Blanc.—The author mentions the systems of Hirzel, of Leipzig, and Riedinger, of Augsburg. In these systems a thin stream of the oily or tarry matter is allowed to trickle into the interior of a cast-iron retort heated to dull redness, where it is converted into gas. This gas, when freed from tar, is, when obtained from certain materials, absolutely exempt from compounds of sulphur. Its illuminating power is from 2½ to 3 times higher than that of the ordinary coal-gas of London and Paris. M. Le Blanc then mentions several systems for mixing common air with the vapour of volatile hydrocarbons.

Composition of Certain Combustible Minerals.—M. Boussingault.—This paper is taken from the *Comptes Rendus*.

March, 1884.

This issue coes not contain any chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c., January and February, 1884.

This number contains no chemical matter, with the exception of certain abstracts from the *Comptes Rendus*.

Cosmos les Mondes.
No. 11, March 15, 1884.

New Use for Peat.—The upper, spongy layer of peat-beds unfit for fuel is, dried and sifted, used as a material for dry closets. One hundred parts of peat-powder render 900 parts of fœcal matter perfectly inoffensive.

MEETINGS FOR THE WEEK

MONDAY, June 2nd.—Royal Institution, 5. General Monthly Meeting.
TUESDAY, 3rd.—Society of Chemical Industry, 8. "On the Processes concerned in the Conversion of Starch into Alcohol, and their Relation to Brewing and Distilling," by Mr. W. S. Squire.
—— Royal Institution, 3. "Nerve and Muscle," by Prof. Gamgee.
THURSDAY, 5th.—Royal Institution, 3. "Flame and Oxidation," by Prof. Dewar.
—— Chemical, 8.
FRIDAY, 6th.—Royal Institution, 8. "Electtric Induction Experiments," by Mr. Willoughby Smith, at 9.
—— Geologists' Association, 8.
SATURDAY, 7th.—Royal Institution, 3. "Microscopical Geology," by Prof. Bonney.

AMMONIACAL LIQUOR.

THE DIRECTORS OF
THE COMMERCIAL GAS COMPANY
are prepared to receive Tenders for the Ammoniacal Liquor produced at their several Works for the Eighteen Months ending June 30, 1886.

The quantities of Coal Carbonised are estimated to be as under, but the same cannot be guaranteed, and may be more or less:—

At the Stepney Works, in the Regent's Canal, about 80,300 tons per annum.

At the Wapping Works, in the Thames, about 33,500 tons per annum.

At the Poplar Works, in Bow Creek (free water-way), about 53,000 tons per annum.

The Tenders may be for the whole, or for one or more Works separately.

The Contractors must give security to remove the Liquor as it accumulates, to pay for the same monthly, and generally for the due fulfilment of the contract.

The form of agreement to be signed can be seen at the Company's Offices on application to the Engineer.

Tenders, sealed, and endorsed "Tender for Ammoniacal Liquor," to be delivered here not later than the 3rd of July next.

The Directors reserve to themselves the right to accept any Tender in part or in whole, and do not bind themselves to accept the highest or any Tender.

By Order of the Board,
H. D. ELLIS, Secretary.

Commercial Gas Works,
Stepney, E.
May, 1884.

NEW PATENT LAW.

Just published,
HANDBOOK OF PATENT LAW.
By W. P. THOMPSON, F. Inst. P.A., Chemical Patent Agent. Sixth Edition, thoroughly revised. English portion, 6d.; all countries, 2s. 6d.

"Will be extremely serviceable."—*Chemical News*.

PATENT OFFICES—6, LORD STREET, LIVERPOOL, and 323, HIGH HOLBORN, LONDON.

THE CHEMICAL NEWS.

VOL. XLIX. No. 1280.

ON THE ESTIMATION OF PHOSPHORIC ACID IN FERTILISERS.

THE OXALIC ACID METHOD COMPARED WITH THE MOLYBDIC.

By DAVID LINDO.

I HAVE estimated the phosphoric acid with great care in seven samples of raw phosphates by the molybdic and oxalic acid methods, for the purpose of testing the accuracy of the latter method when lime and silica are present in addition to certain other bodies, such as ferric oxide and alumina, the influence of which had been previously studied.

I believe the molybdic as recently improved gives results so accurate that it may be safely taken as the standard for comparison in testing the correctness of other methods with unknown quantities of phosphoric acid.

One of the samples was from the Pedro Cays in the neighbourhood of this island; four, phosphatic earths from caves in the island; and the other two, samples of rock and earth phosphates from Nevassa.

SAMPLE A.

From Pedro Cays; ash about 82 per cent.*

The substance consisted chiefly of calcium phosphate and carbonate. Total lime, 44·88 per cent; silica, 0·09 per cent; ferric oxide, only a trace; sulphuric acid and alumina were absent.

B.

Cave earth, ash about 49 per cent, consisting largely of calcium sulphate. The sample did not effervesce with acids. Silica, 0·99 per cent; ferric oxide, very little; alumina, if any, only a trace; operating with 0·56 grm. of the manure, only 0·002 grm. of alumina was obtained. This small quantity may have been derived from the vessels. Total lime 20·45 per cent.

C.

Cave earth, ash about 43 per cent; this sample contained much organic matter. Lime, 3·16 per cent; alumina, 11·06; ferric oxide, 7·18 per cent: sulphuric acid, 2·52 per cent; silica, 0·80 per cent. Carbonic acid was absent.

D.

Cave earth, ash about 47 per cent. Lime, 12·27 per cent; alumina, 5·02 per cent; ferric oxide, 2·27 per cent; silica, 6·88 per cent. Sulphuric acid was present, but not carbonic acid.

E.

Nevassa rock, ash about 93 per cent. Lime, 46·90 per cent, partly as carbonate; alumina, 2·18 per cent; ferric oxide, 2·7 per cent; silica, 0·85 per cent. Sulphuric acid only a trace.

F.

Cave earth, ash about 68 per cent. Lime, 27 per cent; alumina, 5·56 per cent; ferric oxide, 2·24 per cent; silica, 6·50 per cent. Sulphuric acid and carbonic acid were both present.

G.

Nevassa earth, ash about 88 per cent. Lime, 36·20 per cent; alumina, 9·95 per cent; ferric oxide, 3·27 per cent; silica, 3·33 per cent. Carbonic acid only a trace; sulphuric acid was absent.

The alumina and ferric oxide were separated according to the method recommended by Church. My experience leads me to conclude that the separation cannot be very perfectly effected by this process in the presence of much lime.

Preparation of the Samples for the Estimation of Phosphori Acid.

Bruised, mixed well, and weighed about 20 grms. into a mortar, the weight of which with pestle had been accurately taken. Kept in the balance case; carefully ground and weighed the sample from day to day until the weight was sufficiently constant to admit of accurate weighing in small quantities afterwards. Transferred to accurately ground reagent bottle, and noted the loss of weight sustained by the air-drying.

The fusion method recommended by Gilbert was adopted with all the samples. The quantity of each, air-dried, taken for a fusion was equal to 2·5 grms. of the sample in its original condition, and is shown in the following table. When much organic matter was present potassium nitrate was substituted for the chlorate.

Samples.	Lost Moisture per cent Air-dried.	Weight of Sample Air-dried=2·5 grms. in its original condition.
A.	5·77	2·356
B.	26·91	1·828
C.	8·48	2·288
D.	24·18	1·895
E.	0·94	2·477
F.	5·59	2·360
G.	2·08	2·448

The melt was treated with water and nitric acid: a residue always remained, except in the case of sample A, the solution of which was perfectly brilliant. It was considered unnecessary to separate the trace of silica from this sample. The silica in the other samples was separated as completely as possible by evaporation to dryness and heating the residue on the sand-bath at about 120° C. for two or three hours; in some cases for as long as five hours. The residue left on treating the mass with nitric acid and water was never pure silica: it was dried, removed from the filter, the latter burned, and the whole fused again with four times its weight of the oxidising mixture. This melt was treated in the same manner as the first, when the silica, as a rule, separated in a state of great purity. The solutions were united, and the whole accurately weighed.

Weights of Solutions in Grammes.

Samples.	Weights of Solutions each containing =2·5 grms. of manure in its original condition.	Equal Manure per cent.
A.	241·110	1·037
B.	220·671	1·133
C.	228·530	1·094
D.	209·800	1·192
E.	212·953	1·174
F.	195·771	1·277
G.	251·350	0·995

Four estimates were made with each sample, two by each method, one by each together. The quantity of solution taken was first roughly measured, and then carefully weighed.

Molybdic Method.

This was carried out essentially in accordance with the instructions given by Stunkel, Wetzke, and Paul Wagner (CHEMICAL NEWS, vol. xlvii., p. 66). They wash the precipitate with a neutral solution of ammonium nitrate, 100 grms. of the salt dissolved and made up to 1 litre. I used a solution very slightly acidulated with nitric acid,

* As certain constituents in the ash are, as a rule, more or less decomposed during ignition it is impossible to get very concordant results in making two or more estimates with the same sample; I have therefore disregarded fractions.

and containing 150 grms. to the litre. They break the filter, and wash the precipitate into the beaker with dilute ammonia. I dissolved the precipitate *on* the filter by dropping dilute NH_3 (about 6 per cent) on it, and stirring it up with a jet of 2·5 per cent NH_3 delivered from a small wash-bottle.

Oxalic Acid Method.

I must refer the reader to my former article "On the Estimation of Phosphoric Acid" (CHEMICAL NEWS, vol. xlviii., p. 217) for details respecting the best manner of carrying out this process. I followed the same plan in these analyses. In some instances the precipitate was first collected on a pure paper filter, slightly washed, dissolved on the filter in 20 c.c. 10 per cent acetic acid, the solution made up to the usual volume, precipitated with NH_3 added very gradually, then added Mg Mix., and proceeded as usual.

Gooch's method of filtration was used at the end where re-precipitation was resorted to, and when this was done it will be indicated by the letter R. The same method of filtration was adopted in all the other experiments. The precipitates were filtered off after two or three hours, and were finally ignited over the blast.

Solution of Sample A. Factor 1·037.

Molybdic.

	Weight of Solution taken in grms.	Equal Manure.	$Mg_2P_2O_7$ obtained.	Equal P_2O_5.	Equal per cent in Sample.	Averge.
1	64·165	0·6654	0·1514	0·096835	14·55	14·60
2	63·417	0·6576	0·1506	0·096324	14·65	

Oxalic.

1	65·244	0·6766	0·1551	0·099202	14·66	14·63
2	45·340	0·4702	0·1073	0·06863	14·60	

Solution of Sample B. Factor 1·133.

Molybdic.

1	41·324	0·4682	0·0648	0·04145	8·85	8·85
2	41·443	0·4695	0·0650	0·04157	8·85	

Oxalic.

1	41·592	0·4712	0·0656	0·04196	8·90	8·89
2	41·822	0·4738	0·0658	0·04208	8·88	

Solution of Sample C. Factor 1·094.

Molybdic.

1	41·991	0·4594	0·1245	0·07963	17·33	17·31
2	41·256	0·4513	0·1220	0·07803	17·29	

Oxalic.

1	41·498	0·454	0·1247	0·07976	17·57	17·54
2	41·600	0·4551	0·1246	0·07969	17·51	

Solution of Sample D. Factor 1·192.

Molybdic.

1	36·783	0·4384	0·0447	0·02859	6·52	6·53
2	37·243	0·4439	0·0454	0·02904	6·54	

Oxalic.

R 1	36·810	0·4388	0·0482	0·03083	7·03	7·00
R 2	37·040	0·4415	0·0481	0·03076	6·97	

Solution of Sample E. Factor 1·174.

Molybdic.

1	36·964	0·4340	0·1589	0·10164	23·42	23·36
2	37·885	0·4448	0·1621	0·10368	23·31	

Oxalic.

1	37·195	0·4366	0·1620	0·10361	23·73	23·67
2	37·410	0·4392	0·1622	0·10374	23·62	

Solution of Sample F. Factor 1·277.

Molybdic.

1	37·824	0·4830	0·1146	0·0733	15·18	15·13
2	36·923	0·4715	0·1112	0·07112	15·08	

Oxalic.

1	37·232	0·4755	0·1150	0·07355	15·47	15·42
R 2	37·533	0·4793	0·1152	0·07368	15·37	

Solution of Sample G. Factor 0·995.

Molybdic.

1	42·100	0·4189	0·1970	0·1260	30·08	30·06
2	42·650	0·4244	0·1994	0·1275	30·05	

Oxalic.

1	41·925	0·4172	0·1976	0·1264	30·30	30·18
R 2	42·415	0·4220	0·1984	0·1269	30·07	

Another portion of solution, Sample D, containing about 0·5 grm. of the manure, was submitted to the oxalic method, and the precipitate of ammonio-magnesia phosphate collected on a paper filter, washed, dried, removed from the filter, and treated in a platinum dish in the usual way for the detection of silica. 0·002 grm. of the latter was obtained from this precipitate.

It is well known that the usual process—which was the one adopted in these experiments—for the elimination of silica fails to remove it completely. On dissolving the mass that has been heated for some time on the sand-bath in acid and water a trace of silica will as a rule go into solution. I was not aware, however, that this trace of silica would go down with the ammonio-magnesia phosphate. In fact direct experiment has shown that in the absence of alumina and ferric oxide this does not occur. Further experiments proved that even in the presence of ferric oxide, unless in notable quantity, a little silica may be present without vitiating the results to any important extent; but if alumina is present a minute quantity of silica in the solution has a very marked effect.

On the influence of a small quantity of silica in the presence of alumina and ferric oxide two series of experiments were made. A solution of silica was prepared by fusing 0·080 grm. with 2 grammes pure sodium carbonate, dissolving the melt in water, and making up to 200 c.c. 10 c.c. of this solution would therefore contain 0·004 grm. silica. Solution of ferric chloride was prepared. 10 c.c. = 0·035 grm. ferric oxide, and solution of aluminum chloride 10 c.c. = 0·010 grm. alumina. These solutions contained some excess of acid. A solution of microsmic salt was made of the same strength as that used in my experiments already published. The quantity used for each experiment would give about 0·2 grm. $Mg_2P_2O_7$. The solution was always accurately weighed and diluted as usual. The precipitates were ignited over the blast. The results were compared with test experiments, as in my former work. The quantity of phosphoric acid found for 100 parts taken is given as follows:—

First Series.

	Silica, 0·004 grm. Alumina, 0·020 grm. Ferric Oxide, 0·035 grm. Citric Acid, 2 grms.		Silica, 0·004 grm. Ferric Oxide, 0·035 grm. Citric Acid, 2 grms.		Tests corrected for the Blast.
1	102·30	4	99·85	7	100·01
2	102·45	5	100·40	8	100·11
3	103·10	6	100·55	9	100·06
Average	102·61		100·27		100·06

Second Series.

	Silica, 0·004 grm. Alumina, 0·020 grm. Citric Acid, 2 grms.		Silica, 0·004 grm. Ferric Oxide, 0·070 grm. Citric Acid, 2 grms.		Tests corrected for the Blast.
1	102·85	4	100·50	7	100·01
2	103·20	5	100·30	8	99·96
3	103·45	6	100·65	9	99·86
Average	103·16		100·48		99·94

On adding the ammonia in these experiments after introducing the citric acid, no turbidity was observed, nor was any apparent at this stage of the process in the analyses of the raw phosphates, even when the mixture was allowed to stand for some time before adding the Mg mix.

The following experiments were next made :—

No. I.

25 c.c. water.
1 grm. citric acid.
10 c.c. sol. silica = 0·004 grm.
10 c.c. sol. aluminum chloride = 0·010 grm.
10 c.c. 6 per cent NH_3.

The mixture remained quite brilliant, even after standing some time. Added 20 c.c. Mg mix. No. II. Immediate turbidity and after a little time a precipitate fell.

No. II.

Used all reagents as above except the sol. of silica, of which only 5 c.c. = 0·002 grm. were introduced.

On adding the Mg mix. no turbidity at first, but it soon appeared; on standing a few minutes a precipitate fell.

Hence it appears aluminum silicate is soluble to a small extent in ammonium citrate, but *not so* in the presence of Mg mix.

It is apparent that the oxalic method, when applied to the estimation of phosphoric acid in fertilisers, will not as a rule give results strictly accurate, and the experiments detailed above seem clearly to show that this is due to its being practically impossible to remove all traces of silica from the solution, and that a minute quantity of this body will vitiate the results if alumina also is present. Disolving the precipitate in acid and re-precipitating does no good. In only one experiment out of four where this was done did the result agree with the molybdic, and this must therefore be considered accidental. I may state that a few milligrms. of citric acid were always added before re-precipitating. Samples A and B, it will be observed, gave concordant results with the two methods. In A alumina was absent; in B, if any was present, it could have only been a trace.

It has been held by many that it is unnecessary to separate the silica when the molybdic method is employed. Such experiments as I have made certainly prove that the $Mg_2P_2O_7$ will be free from silica if the quantity of the latter originally present in the solution was small. No silica was found in such of the precipitates from the molybdic method as I examined, and in one experiment with a solution of microsmic salt in which I introduced 0·008 grm. silica, and 0·040 grm. alumina,—being double the quantities used in the experiments that gave results so much above the truth by the oxalic method,—99·90 P_2O_5 was obtained instead of 100.

Experiments, however, with much larger quantities of silica, gave results not quite so satisfactory; therefore, in practice, I should remove it as completely as possible by the usual method before adding the molybdic reagent.

As regards the lime, in carrying out the oxalic method, a minute quantity remains in solution after adding the ammonium oxalate in excess, as the oxalic acid set free has a slight solvent action on the calcium oxalate. As this trace will go down on adding the ammonia and Mg mix. supposing no citric acid has been used, a second precipitation after dissolving in acetic acid is generally recommended. The necessity for this, however, may be obviated by adding 1·5 to 2 grms. citric acid at the proper stage, whether aluminum and iron are present or not, and counteracting the solvent action by the use of sufficient Mg mix., for—as I have proved by direct experiment—the formation of calcium oxalate is so greatly retarded by the presence of ammonium citrate, that if enough of the latter exists in the solution, and there is present only a little lime, it will be many hours before any trace of the latter is precipitated, even in presence of Mg mix.; therefore, if the ammonio-magnesia phosphate is filtered off after 3 or 4 hours, it will be found free from lime. On the other hand, I have found that with sufficient excess of Mg mix. the P_2O_5 will, in presence of ammonium citrate and oxalate, be precipitated as completely in two hours as in ten or more.

After nearly neutralising with NH_3, precipitating with oxalate in the heat, and filtering off the lime, I concentrate filtrate and washings to 30 c.c. to 40 c.c. A small further precipitate of calcium oxalate often forms, which is filtered off. The filtrate is made up with washings to the usual volume, citric acid added, then NH_3 and Mg mix.

Falmouth, Jamaica, B.W.I.
March 29, 1884.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

TITANIUM.

THE earliest determinations of the atomic weight of titanium are due to Heinrich Rose.† In his first investigation he studied the conversion of titanium sulphide into titanic acid, and obtained erroneous results; later, in 1829, he published his analyses of the chloride.‡ This compound was purified by repeated rectifications over mercury and over potassium, and was weighed in bulbs of thin glass. These were broken under water in tightly stoppered flasks; the titanic acid was precipitated by ammonia, and the chlorine was estimated as silver chloride. The following results were obtained. In a fourth column I give the TiO_2 in percentages referred to $TiCl_4$ as 100; and in a fifth column the quantity of $TiCl_4$ proportional to 100 parts of AgCl :—

$TiCl_4$	TiO_2.	AgCl.	Per cent TiO_2.	AgCl Ratio.
0·885 grms.	0·379 grms.	2·661 grms.	42·825	33·258
2·6365 ,,	1·120 ,,	7·954 ,,	42·481	33·147
1·7157 ,,	0·732 ,,	5·172 ,,	42·665	33·173
3·0455 ,,	1·322 ,,	9·198 ,,	43·423	33·100
2·4403 ,,	1·056 ,,	7·372 ,,	43·273	33·102
		Mean	42·933 ± 0·121	33·156 ± 0·019

If we directly compare the AgCl with the TiO_2 we shall find 100 parts of the former proportional to the following quantities of the latter :—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Gilbert's Annalen*, 1823, 67, and 129.
‡ *Poggend. Annal.*, 15, 145. *Berz. Lehrbuch*, 3, 1210.

14·243
14·081
14·153
14·373
14·324

Mean 14·235 ± 0·036

From all these figures we can get three values for Ti, thus :—

From per cent TiO_2.. ..	Ti = 50·493	±	0·410
,, AgCl : $TiCl_4$	,, 48·232		0·127
,, AgCl : TiO_2	,, 49·523		0·206
General mean ..	,, 48·710		0·105

These results will be discussed further along in connection with others.

Shortly after the appearance of Rose's paper, Mosander* published some figures giving the percentages of oxygen in titanium dioxide, from which a value for the atomic weight of titanium was deduced. Although no details are furnished as to experimental methods, and no actual weighings are given, I cite his percentages for whatever they may be worth :—

40·814
40·825
40·610
40·180
40·107
40·050
40·780
40·660
39·830

Mean 40·428

These figures give values for Ti ranging from 46·277 to 48·231; or, in mean, Ti = 47·045. They are not, however, sufficiently explicit to deserve any further consideration. It will be noticed that the highest value nearly coincides with Rose's lowest.

In 1847 Isidor Pierre made public a series of important determinations.† Titanium chloride, free from silicon and from iron, was prepared by the action of chlorine upon a mixture of carbon with pure artificial titanic acid. This chloride was weighed in sealed tubes, these were broken under water, and the resulting hydrochloric acid was titrated with a standard solution of silver after the method of Pelouze. I subjoin Pierre's weighings, and add, in a third column, the ratio of $TiCl_4$ to 100 parts of silver :—

$TiCl_4$.	Ag.	Ratio.
0·8215 grm.	1·84523 grm.	44·520
0·7740 ,,	1·73909 ,,	44·506
0·7775 ,,	1·74613 ,,	44·527
0·7160 ,,	1·61219 ,,	44·412
0·8085 ,,	1·82344 ,,	44·339
0·6325 ,,	1·42230 ,,	44·470
0·8155 ,,	1·83705 ,,	44·392
0·8165 ,,	1·83899 ,,	44·399
0·8065 ,,	1·81965 ,,	44·322

Mean 44·432 ± 0·0173

It will be seen that the first three of these results agree well with each other and are much higher than the remaining six. The last four experiments were made purposely with tubes which had been previously opened, in order to determine the cause of the discrepancy. According to Pierre, the opening of a tube of titanium chloride admits a trace of atmospheric moisture. This causes a deposit of titanic acid near the mouth of the tube, and liberates hydrochloric acid. The latter gas being heavy, a part of it falls back into the tube, so that the remaining chloride is richer in chlorine and poorer in titanium than it should be. Hence, upon titration, too low figures for the atomic weight of titanium are obtained. Pierre accordingly rejects all but the first three of the above estimations :—

From all of Pierre's.. ..	Ti = 49·889	±	0·096
,, the first three.. ..	,, 50·259		0·063

The memoir of Pierre upon the atomic weight of titanium was soon followed by a paper from Demoly,* who obtained much higher results. He also started out from titanic chloride, which was prepared from rutile. The latter substance was found to contain 1·8 per cent of silica; whence Demoly inferred that the $TiCl_4$ investigated by Rose and by Pierre might have been contaminated with $SiCl_4$, an impurity which would lower the value deduced for the atomic weight under consideration. Accordingly, in order to eliminate all such possible impurities, this process was resorted to : the chloride, after rectification over mercury and potassium, was acted upon by dry ammonia, whereupon the compound $TiCl_4.4NH_3$ was deposited as a white powder. This was ignited in dry ammonia gas, and the residue, by means of chlorine, was re-converted into titanic chloride, which was again repeatedly rectified over mercury, potatsium, and potassium amalgam. The product boiled steadily at 135°. This chloride, after weighing in a glass bulb, was decomposed by water, the titanic acid was precipitated by ammonia, and the chlorine was estimated in the filtrate as silver chloride. Three analyses were performed, yielding the following results. I give the actual weighings :—

Grms.		Grms.		Grms.	
1·470 $TiCl_4$ gave		4·241 AgCl and		0·565 TiO_2.	
2·330	,,	6·752	,,	0·801	,,
2·880	,,	8·330	,,	1·088	,,

The "0·801" in the last column is certainly a misprint for 0·901. Assuming this correction, the results may be given in three ratios, thus :—

Per cent TiO_2 from $TiCl_4$.	$TiCl_4$: 100 AgCl.	TiO_2 : 100 AgCl.
38·435	34·662	13·322
38·669	34·508	13·344
37·778	34·574	13·061
Mean 38·294 ± 0·180	34·581 ± 0·030	13·242 ± 0·061

These three ratios give three widely divergent values for the atomic weight of titanium :—

From per cent TiO_2.. ..	Ti = 36·063	±	0·519
,, AgCl : TiO_2	,, 43·841		0·350
,, AgCl : $TiCl_4$	,, 56·386		0·181
General mean ..	,, 52·191		0·153

The value assumed by Demoly is 56, who employs but one ratio and ignores practically the others.

Upon comparing Demoly's figures with those obtained by Rose, certain points of similarity are plainly to be noted. Both sets of results were reached by essentially the same method; and in both the discordance between the percentages of titanic acid and of silver chloride is glaring. This discordance can rationally be accounted for by assuming that the titanic chloride was in neither case absolutely what it purported to be; that, in brief, it must have contained impurities; such for example as hydrochloric acid, as shown in the experiments of Pierre, or possibly traces of oxychlorides. Considerations of this kind also throw doubt upon the results attained by Pierre, for he neglected the direct estimation of the titanic acid altogether, thus leaving us without means for correctly judging as to the character of his material. In fact, not one of the determinations of the atomic weight of titanium can be regarded as trustworthy. All depend upon the chloride, and the volatile chlorides of metals are as a class especially liable to contaminations of a kind most difficult to recognise. Possibly a series of good

* *Berz. Jahresbericht.* 10, 108. 1831.
† *Ann. d. Chim. et de Phys.*, (3), 20, 257.

* *Ann. Chem. Pharm.*, 72, 214 *Berz. Jahresb.* 30, 58.

determinations might be based upon analyses of some of the titano-fluorides. I subjoin a combination of the foregoing mean values, feeling that such a general average is a little better than any one set of determinations taken singly :—

From Rose's analyses ..	Ti = 48·710	±	0·105
,, Pierre's ,, ..	,, 49·889		0·096
,, Demoly's ,, ..	,, 52·191		0·153
General mean ..	,, 49·846		0·064

Or, O = 16, Ti = 49·961.

This mean agrees with the average of all of Pierre's experiments.

The following additional note has been communicated by the author :—

All the foregoing work upon titanium has been completely supplanted by the recent researches of Thorpe. As his paper has quite lately appeared in the CHEMICAL NEWS (vol. xlviii., p. 251) its details need not be reiterated here; but a statement of the results obtained by recalculating his figures may fairly be given.

First, in eight experiments, $TiCl_4$ was decomposed by water and titrated against silver solution. In mean, 100 parts of silver balance 43·999, ± 0·0032, of $TiCl_4$. Hence Ti = 48·024 ± 0·065.

Second, in five experiments $TiCl_4$ was similarly decomposed, and the chlorine was weighed as AgCl. In mean, 100 parts of AgCl balance 33·118 ± 0·0019 of $TiCl_4$. Hence Ti = 48·015 ± 0·068.

Third, in six experiments $TiCl_4$ was decomposed by water, the solution was evaporated to dryness, and the residual TiO_2 was weighed. In mean, $TiCl_4$ yields 42·171 ± 0·0022 per cent of TiO. Hence Ti = 47·963 ± 0·043.

The general mean of these three values is Ti = 47·980 ± 0·032. If O = 16 this becomes 48·100. The complete concordance of the three results establishes the purity of the material studied.

A FLASHING TEST FOR GUNPOWDER.

By C. E. MUNROE, S.B. (Harv.).

AMONG the methods in use for the determination of the condition and quality of gunpowder is the "flashing test." According to the "Ordnance Instructions U.S. Navy," p. 345, "about eight drams of powder are poured on a glass plate so as to form a conical heap, and 'flashed' by applying a hot iron; no residuum should be left and only a few smoke marks should be seen on the plate." Capt. Smith, R.A., in his "Handbook of the Manufacture and Proof of Gunpowder," p. 83, proceeds in the same way, but he places the powder in a thimble-shaped, copper cylinder, "which is then inverted on the flashing plate. This provides for the particles being arranged in pretty nearly the same way each time, which is an all-important point in flashing. The decomposition of the powder will be more thorough if it be thrown together in a conical heap than if it be spread out in a thin layer on the plate; hence, for comparison of different powders, they should be placed on the plates as nearly as possible under the same conditions. If the powder has been thoroughly and effectually incorporated the small charge placed on the plate will 'flash' or puff off when touched with a hot iron, leaving only smoke marks on the plate. A badly incorporated powder will, on the other hand, leave specks of undecomposed saltpetre and sulphur, and will therefore give a dirty residue. But the 'flashing' test, though apparently most simple, is one which, like the examination by eye and hand, requires experience to enable the observer to form an accurate judgment. Though a very badly incorporated powder could be detected at once, it is by no means easy to judge between two powders, both tolerably good, as to which has undergone the most thorough incorporation. Flashing should therefore be constantly practised with all classes of powders, and it is useful to keep some samples of bad powders to flash occasionally for comparison. Powder which has once been subjected to and injured by damp will be found to flash very badly, no matter how carefully its incorporation may have been performed. This arises from a partial solution of the saltpetre having taken place, causing a consequent disturbance of the incorporation."

Com. J. D. Marvin, U.S.N., in his "Objects and Resources of the Naval Experimental Battery, p. 18, repeats the above directions and suggests weighing the plate on which the flash has been made, but, as he provides no means to prevent the absorption of moisture and oxygen, and the escape of the hydrogen and ammonium sulphides, the method is of no value.

In the *Comptes Rendus*, 78, 1138, 1874, Col. Chabrier proposes, what he terms a *pyrographic* method for the examination of gunpowder, and a detailed account is given in the *Revue d'Artillerie*, iv., 396, 1874, of its application by the Comité de L'Artillerie in determining the relative value of wheel mills, stamp mills, and *moulins à tonneaux* in effecting incorporation, and of the length of time necessary in each case to produce the desired result.

This method consists in flashing the powder on sheets of paper, coloured blue with iodide starch. Sheets of uniform tint, 0·30 metre long by 0·15 metre wide, are dampened and placed on a plate of glass of the same size. A half gram of powder is then trailed on the paper, following the longer axis. It is flashed by a red hot iron wire and it is found that the centre of the blue paper is bleached, while black spots and streaks appear on the white ground and white spots on the blue ground. The size and shape of the bleached space and the number and arrangement of the spots and streaks are determined by the character and amount of the powder used. Col. Chabrier does not give the *rationale* of his process, but it is to be inferred from the fact that he styles these results *pyrographic* images that he believes the breaching to be due to the heat evolved by the combustion. The well-known experiment of the bleaching of starch paste, coloured blue with iodine, by heating in a test-tube, is an example of the same kind.

This process is an advance upon the older one, but in applying it some years ago I found it difficult to prepare papers of the same degree of blueness, and that the evanescent character of the colour made it difficult to preserve the test papers intact for any considerable length of time; so, as before, we must either practise the method continually or else flash powders, which we have kept as standards for comparison, with each set of tests we make, in order to arrive at any good results. Or, finally, we may photograph the test papers, but this involves considerable labour and the loss of the colour.

Since the flashing test is the simplest, readiest, and in the hands of an expert the best, test for the incorporation of powder, and since it also fairly indicates the amount of deterioration which a powder has undergone during transportation and storage, it has seemed to me desirable to seek some method by which the record could be made permanent. Such a record could then be filed at the factory with the other data concerning a given powder, or, in the case of the Government, they could be inclosed with the quarterly returns of the inspecting officers at distant stations, to be examined by some expert in the Bureau. Specimens of the tests of standard powders could also be furnished inspecting officers, to guide them in the interpretation of the results of their tests, and finally, a sample of the required test might be attached to the specifications for a gunpowder to be purchased.

After some search I believe I have secured such a permanent record, by employing a paper coloured with Turnbull's Blue, upon which to make my flash. This paper is the same as that used in the "Blue Print Process" of photography, and is easily procured in commerce. The

use of the paper was suggested by the following facts. When gunpowder burns the reaction which takes place may, according to Debus, *Proc. U. S. Naval Institute*, 9, 76, 1883, be represented by the reaction—

$$16KNO_3+13C+5S=3K_2CO_3+5K_2SO_4+9CO_2+CO\times\times 8N_2.$$

Sincs, however, in ordinary gun powders there is more carbon and sulphur than is required by the above equation, secondary, endothermic reactions take place,which may be combined and represented as follows :—

$$3K_2SO_4+2K_2CO_3+7C+7S=5K_2S_2+9CO_2.$$

Further, on exposure to the air, the polysulphides formed are oxidised to thiosulphates. I have observed that, in my experiments, the characteristic smell of the latter was most noticeable when the powder was badly incorporated.

It is well known that solutions of the alkalies and the alkaline carbonates decompose Turnbull's Blue and thereby destroy its colour. Advantage has been taken of this reaction to increase the distinctness of "Blue Prints," or to make such additions to them or alterations in them as desired. With this I exhibit a specimen of the blue paper, upon which one of the above reactions is written by the aid of a solution of potassium carbonate. The alkaline sulphides and thiosulphates also act upon the blue paper, but with less intensity and with the partial production of a yellow colour. By flashing gunpowder then, upon such paper, yellow and white spots will be formed through the action of the substances formed by the reaction.

The test is made as follows:—Pieces of the paper, from 15 to 20 centimetres square, are dampened and placed on a sheet of glass or copper. A truncated leaden cone 3 centimetres in capacity is closed with the finger at the smaller end, filled evenly with powder, and inverted on the paper. The result is a conical heap. The heap is immediately fired, either by a hot iron or copper wire, or, as in my experiments, by a fine platinum wire, heated to incandescence by an electric current. The paper is exposed to the action of the residue for thirty seconds and then immediately placed under the spigot and washed with running water. When pulverised gunpowder cake is used it will be found that the space described by the base of the cone has been blackened and partially bleached by the dampened layers of powder in contact with it: that about this space are black smutches and streaks, and that the whole surface of the paper is marked by white and yellow dots. Where the powder is badly incorporated the spots are coarse, and irregular in shape and distribution; where the incorporation is complete, the spots are fine and quite uniformly distributed over the surface, so that the paper appears but of a paler blue, with occasional spots and few streaks.

With this I forward specimens of tests made with powdered "milk cake." All of the specimens belong to the same "charge," but the first was drawn after the mill had been running four hours; the second, at the end of eight hours; the third, after twelve hours; and the fourth, after sixteen hours. The latter is known as the "finished composition." This length of running is rather unusual, but the charge used at the mills is greater than common. The tests exhibited were made October 19, 1883. I have yet others made April 26, 1883, which are to-day apparently as fresh and distinct as when made. It is believed that the papers show what is described above. That importance is given, in interpreting the results, to uniformity of the bleaching and in the arrangement of the spots, depends upon the fact that gunpowder is a mechanical mixture, and, therefore, that the regularity of the combustion and the uniformity of the accompanying reactions must depend upon the fineness of the ingredients and the intimacy and uniformity of the mixture. If the ingredients are coarse and the mixture imperfect, the combustion will go on slowly and irregularly, and the resulting globules of residue will be of considerable size and be deposited near the centre of action. If the incorporation is complete, the reaction will take place nearly simultaneously throughout the whole mass, and the globules will be, as a rule, quite small and projected to some distance. This interpretation is for mealed powders having the same formula. I have not yet been able, personally, to extend my experiments to granulated powders or powders of varying proportions and ingredients, but I believe that this test will form a useful method for the study of these powders.

In order that the indications may be interpreted aright, it is necessary that the conditions under which the experiments are made shall be as nearly uniform as possible, and the first of these is that the colour of the test paper should be in all cases as nearly as possible of the same depth. The paper may be purchased in an emergency, but it varies among manufacturers owing to the many different formulæ according to which it is made. Among these I have selected that issued by the Penn. R. R. Co. for use among its operatives.

"Take 10 ozs. (283·5 c.c.) of clean water and put in an opaque bottle, add 1¼ oz. (35·44 grms.), of red prussiate of potash; allow this to dissolve. In a second vessel containing 6 ozs. (170·1 c.c.) of water put 2½ ozs. (70·88 grms.), of ammonio-citrate of iron, allowing this also to dissolve. Add the second liquid to the first and shake thoroughly. Keep closely stoppered and not exposed to light."

"In a room from which daylight is excluded, but where lamp or gas light may be used, the paper to be printed on is laid on a table, and the fluid applied with a *clean* sponge. Care should be taken to apply the fluid as evenly as possible, and every part of one side should be gone over. For that reason it would be well to sponge the paper, first in one direction, and afterwards crosswise to the first. When a sheet is sensitised it is put away in a drawer to dry, but never place one sheet on the top of another before they are dry; afterward it makes no difference. Sensitised paper may be kept in a drawer for a week or more, without injuring its sensitive quality."

"In using the fluid, care should be taken to pour out no more than is needed for the time, as it would be apt to spoil the fluid in the bottle if any fluid which had been used was poured back again. For the same reason the saucer into which the fluid is poured, and the sponge with which it is applied, should be washed out immediately after using and also before using."

For the purposes of this test for gunpowder the dry sheets are now exposed to strong sunlight for four or five hours. When about to use, immerse in running water for five minutes, lay on the plate of glass and remove the excess of moisture by aid of filter-paper or a blotter. The paper must be thoroughly moistened, but without "standing" moisture.

Since writing the above I have received from Lieutenant Commander W. M. Folger, U.S.N., commanding the Naval Experimental Battery, the following statement concerning the testing of a granulated powder by this method.

"In firing a sample of experimental powder lately, I had reason to believe, from its performance in the gun (calibre 6″), that the powder was badly incorporated. Tested in the manner you suggested with Turnbull's paper and following all your directions, indications were furnished which (when compared with results obtained with a normal sample of approved powder) verified most definitely the value of the method you suggest."—*Journal of the American Chemical Society.*

Transmission of Sound by Gases.—M. Neyreneuf.—The author finds no difference between air, nitrogen binoxide, and hydrogen bicarbide, the densities of which are almost equal. The law indicated (*Comptes Rendus*, vol. xcvi.) for carbonic acid applies with sufficient accuracy to nitrogen protoxide and ammonia.—*Comptes Rendus*,

A SIMPLE METHOD OF EXTRACTING CÆSIUM AND RUBIDIUM COMPOUNDS FROM HEBRON LEPIDOLITE.

By F. C. ROBINSON and C. C. HUTCHINS.

Lepidolite from Hebron, Maine, has been shown to contain cæsium and rubidium in considerable quantities. The following is a simple and effective method of obtaining the compounds of these metals:—

The mineral is pounded in an iron mortar until it feels soft to the touch; mixed in the mortar with an equal weight of fluor-spar, and the two ground together for a few minutes to secure intimate mixture. The mixture is transferred to a leaden dish, made into a thin paste with common strong sulphuric acid, and heated on a sand-bath for two or three hours, or until the mass is hard and dry.

When cold the mass is broken up, placed in a porcelain dish, and boiled out three times with water, the water in each case being poured, while hot, through a filter.

The filtrate contains cæsium, rubidium, and potassium as alums. These alums are about equally soluble in hot water, but at 17° the potash alum is nearly six times more soluble than the rubidium alum, and twenty-two times more soluble than the cæsium compound (Redtenbacher). Hence it is easy, by means of these differences, to separate the rubidium and cæsium compounds from the last traces of potassium, and from each other.

1000 grains of lepidolite, treated in the above manner, yield about 30 grains of cæsium and rubidium alums.

The process seems to commend itself on account of (1) its cheapness, the only reagents used being common fluor-spar and sulphuric acid; (2) the short time required —but a single day; (3) avoiding the use of platinic chloride, and fusion of the mineral.—*American Chemical Journal*, March, 1884.

AMMONIUM FLUORIDE AS A BLOWPIPE REAGENT.

By Prof. N. W. LORD, E.M., Ohio State University, Columbus, Ohio.

The use of bisulphate of potassa and fluor spar as a reagent for developing the flame colouration of boron is well known; but the alkali present prevents the application of the method for liberating some other bodies in the same way. I find fluoride of ammonium, on the contrary, has all the value of fluor-spar as a source of fluorine, admits of much easier application, and is a most useful reagent for detecting the alkalies, boron, and other similar bodies in their mineral combinations. The method of using the reagent is simple. For testing felspar, or similar silicates, a little of the powdered mineral is mixed with this reagent, then placed on a piece of platinum, and moistened with sulphuric acid; the mixture allowed to stand a few moments, or else gently warmed, taken upon a loop of platinum wire, and tested either in the blowpipe flame or in a Bunsen burner, being dried a little on the wire first. The alkali flame is nearly as well shown as with the pure salts. As the fluoride of ammonium is permanent, is easily obtained free from alkalies and boron, and can be kept indefinitely in a small wooden box, it is always easy to use.

As a test for boron the reaction is of surprising delicacy. The fact that the fluoride of boron is volatile at a temperature far below that required for alkalies permits thus its detection in borax or any alkaline compound. To a drop of sulphuric acid, placed on a platinum crucible cover, a few grains of the fluoride should be added, and then the mineral (powdered) to form a paste. This is taken as before described, as a platinum loop. It should be heated gently until it stops "sputtering" from escape of free acid and water (but on no account heated to redness), then brought not *in*, but *near*, the lower part of the flame of a Bunsen burner or a good blowpipe flame. A bright green colouration is at once given, untinged by soda-yellow. The colouration is, of course, evanescent, and disappears before the assay is red-hot. A little practice is needed to find the right part of the flame, to get the right heat, and at the same time to draw the volatile boron compound into the heated zone.

This reaction showed boron very strongly in all the specimens of tourmaline tested. With a hand spectroscope the application of this method gives instant proof of the existence of boron, potassa, soda, and lithia, even in very small traces in rocks.

Borax treated in this way gave a bright green flame, almost like copper.—*Engineering and Mining Journal.*

NOTICES OF BOOKS.

A Treatise on Chemistry By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in the Victoria University, Owens College, Manchester. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry. Part II. London: Macmillan and Co.

This valuable work advances slowly to completion. The present volume comprises a general account of the olefines, their substitution products, the methylene, ethylene, ethidene, glycolyl compounds, proceeding thence on to the olefines containing more than eight atoms of carbon. Next follow the uric acid derivatives, including caffeine and theo-bromine, which, to the horror of non-chemists, are now found to stand in close relation to excrementitious principles such as uric acid. The writers even suggest that it may be possible to prepare theo-bromine and caffeine from guano. Fortunately, two circumstances oppose themselves to this fresh inroad upon the domain of agriculture: the world's stock of guano is rapidly diminishing, and caffeine and theo-bromine, though they occur in several important articles of food, do not of themselves constitute such articles. These two bodies, though capable of combining with acids and having a feeble basic character, are now no longer classed among the alkaloids. Caffeine, the methyl derivative of theo-bromine, has the distinguishing privilege of being poisonous, though the quantity likely to prove fatal to a man is not likely to be taken in the form of tea or coffee.

Among the uric acid group we find, further, murexide (ammonium purpurate) now dethroned from its position as a dye-ware. It is said that about twenty-five years ago murexide was used in dye- and print-works in such quantity that the factory of Mr. Rumney, in Manchester, turned out 12 cwts. weekly, consuming for this purpose 12 tons of guano. This manufacture, we are told, was but short-lived, as it was soon superseded by the coal-tar colours, which are equally beautiful and less costly. It must not be forgotten that the gradual decline of Peruvian guano in quality coupled with a rising market-price had an unfavourable influence on this manufacture.

Upon the uric acid derivatives follow the compounds of triad radicals, among which stands foremost glycerin, or, as the authors prefer to name it, glycerol. We have a full account of the preparation of this important compound both from fats and oils and from the waste lyes of soap-works. Among the applications of glycerin we find no mention of its uses in dyeing and the collateral arts.

Amongst its derivatives a prominent place is naturally given to propenyl tri-nitrate, the evil spirit of the age, better known as nitroglycerin. It may well be questioned whether the mischief already wrought by this compound

does not outweigh all the benefits which may arise from its legitimate uses. The fats and oils, those namely which along with trioleine contain glycerides of the fatty acids, are noticed somewhat briefly.

Among the lecithins we find mention of the disputed body protagon, said by some to consist of a mixture of lecithin and cerebrin. We find here no notice of its alleged preparation from vegetable sources.

Passing over the allyl, acryl, and crotyl compounds, we come to citric acid. Concerning the occurrence of this acid we find an apparent slip of the pen. It is remarked that citric acid "accompanied with little or no malic acid is found in the whortleberry," whilst in the next sentence we read that "together with about an equal quantity of malic acid it is found in the bilberry." Now we have always understood that "whortleberry" and "bilberry" are synonyms for one and the same fruit, the former name being used in the West and the latter in the North of England.

The carbohydrates are discussed at great length. We find, however, no reference to the opinion now entertained in some quarters that cane-sugar (saccharose) and beet-sugar (betose), though agreeing in their centesimal composition, are not truly identical, but must be regarded as isomers.

The manufacture and the analysis of sugar are described at length with the accompaniment of numerous and well executed illustrations.

The uses of starch-sugar, chiefly fraudulent, are duly noticed.

Under gum arabic we find the statement quoted from the *Annales de Chemie et Pharmacie* that "silk worms and other insects contain gum of a similar character." It might have been well to state in what part of the body of such insects this gum is secreted and stored up, since possibly some persons may mistake the silk, in its original fluid state, for gum. We need scarcely say that it differs by containing nitrogen, which the gums do not.

Under cellulose we find due mention of its most prominent derivative, gun-cotton or cellulose hexnitrate, formerly supposed to be a trinitrate. It is remarkable that this substance, though it has occasioned no little mischief in other ways, has not been employed by assassins and other criminals to the same extent as dynamite. With reference to the great Stowmarket explosion of August, 1871, we find the following remark:—"On investigation it was ascertained that some of the stock of gun-cotton contained acid, *owing either to insufficient washing*, or to the felonious addition of acid to the properly washed gun-cotton." The addition of the words which we have italicised is, in our opinion, to be regretted. If the gun-cotton had been insufficiently washed it is simply inconceivable that there could have been found in each of some twenty boxes examined one disk of acidified cotton, whilst the rest was perfectly sound and good. In accordance with these facts the jury returned no alternative verdict, but positively declared that acid had been maliciously added to a part of the finished stock.

In treating of the technical uses of cellulose, most of which are of course of a mechanical character, the authors give a series of well executed illustrations showing the microscopic characters of the fibres of cotton, flax, and hemp. Mention is made of the discoveries of Luca and Virchow that cellulose occurs in the skin of silkworms, of snakes, in the human brain, and in the diseased spleen.

The volume before us fully maintains the reputation earned by the former portions of the work for accuracy and thoroughness. There is not in the English language any systematic treatise on chemistry which can be compared with it in these essential respects. The student who wishes for more detailed information on any particular subject finds at the foot of almost every page references to the original memoirs from which the text has been compiled. The index is full, and as far as we have been able to test it, accurate.

The Scientific Papers of James Prescot Joule, D.C.L., LL.D., F.R.S., &c. Published by the Physical Society of London. London: Taylor and Francis.

THIS volume contains those papers which have appeared in the author's own name, arranged, as nearly as possible, in chronological order. In it we find a rare wealth of important research on the most varied physical questions. Electricity, magnetism, heat, sound, as well as the physical side of chemistry, have chiefly occupied the author's attention, and it is not too much to say that whatever he touched he has adorned.

In view of an important enquiry now in progress we will first call attention to one of Mr. Joule's less known memoirs, treating on the "Utilisation of the Sewage of London and other large Towns." We cannot without gratification notice that his views coincide in the main with those which have been advocated in the CHEMICAL NEWS. He protested against the "main drainage scheme," which is now found wanting, as "a stride in the wrong direction, which if persevered in and copied by other towns must be fraught with disastrous consequences to the national prosperity." He condenses the meaning of a notorious passage in the report of the Government Referees as follows:—"We will take care to dilute and remove the sewage, and when, as we have shown, private enterprise will be unremunerative we will invite it." He asserts, in complete accordance with the conclusion recently come to by the Commission of enquiry, that "the portion of sewage which arrives at the outfalls will not be entirely prevented from returning to the metropolis." He bases this conclusion that the sea-water penetrates occasionally as far as London Bridge. He further quotes the admission of Messrs. Hawksley, Bidder, and Bazalgette, that it is "extremely undesirable in a sanitary point of view to cause sewage-water to be intermixed with sea-water," and their additional conclusions "that the cost and difficulties attending the application of liquid sewage in large quantities are absolutely prohibitory of its use," and further, "that liquid sewage cannot in general be used with advantage in this climate, except in particular states of the weather and in certain stages of the growth of the crops to which it is applied." Mr. Joule proposes a return to a modified cesspool system, the excreta being received in air and water-tight tanks, serving each, say, 50 houses, and emptied every night with proper appliances, chemical and mechanical, to prevent nuisance.

Perhaps the most celebrated among the 98 memoirs contained in the volume before us is that on the mechanical equivalent of heat, read before the Royal Society in 1849. The author traces the history of the now accepted theory of the non-materiality of heat from the conjecture of Locke and the experiments of Count Rumford to the more precise determinations of the present day. He describes at length the apparatus and the method of experimentation by which he proved that heat was liberated in measurable quantities by the friction of water, of mercury, and of cast-iron. These experiments led him to the now well-known propositions:—"That the quantity of heat produced by the friction of bodies, solid or liquid, is always proportional to the quantity of force expended," and "that the quantity of heat capable of increasing the temperature of a pound of water (weighed in vacuo and taken at between 55° and 60° by 1° F., requires for its evolution the expenditure of a mechanical force represented by the fall of 772 lbs. through the space of 1 foot."

In a memoir on some amalgams conducted with especial attention to their physical properties, Mr. Joule mentions the fact that the amalgams of lead and of tin are decomposed by pressure. This reminds us of the recent experiments of Prof. Spring on pressure as a chemical agent. Mr. Joule made an unsuccessful attempt to form an amalgam of hydrogen and mercury at 4° F. No trace of hydrogen was taken up, but the author thinks that with the aid of intense cold and high pressure this interesting experiment might be successful.

A very noteworty paper is that on the fusion of metals

by voltaic electricity. Mr. Joule witnessed and afterwards repeated certain experiments in this direction. With a battery of six Daniells he succeeded in fusing several steel wires into one, uniting steel wire with brass, platinum with iron, &c. The wires were placed in glass tubes and surrounded with charcoal to prevent oxidation. The author suggests that this process might be of some utility in place of soldering whenever it is required to join together sparingly fusible metals without the interposition of another which melts at a lower temperature, and which, moreover, is in many cases readily acted on by a variety of chemical agents.

Mr. Joule shows, indeed, that so long as the battery is used as the source of the voltaic current this process cannot be profitably used on the large scale, since 5000 grains of zinc would be the minimum consumption in a Daniell element to effect the fusion of 1 lb. of iron, whilst 1-5th the weight of coal would have the same effect. But he does not forget that the current can be much more economically obtained by a magneto-electrical machine. Thus metallurgical operations may be profitably conducted in mountain regions where coal is wanting if water-power is available.

In 1871 Mr. Joule was led to examine into the "Alleged Action of Cold in rendering Iron and Steel Brittle." From a series of carefully conducted experiments he infers that frost does not make iron (cast or wrought) or steel brittle, and that the accidents said to spring from this cause are in reality due to the omission to submit wheels, axles, &c., to practical and sufficient tests before using them. The greater frequency of such accidents in frosty weather he attributes to the greater rigidity of the ground.

In an essay on "Shooting Stars" the author mentions the three hypotheses put forward by Sir J. Lubbock for their explanation. His own theory, like that of Chladni, is that meteorites are miniature planetary bodies, their ignition being due to their violent collision with our atmosphere, thus affording a "remarkable illustration of the doctrine of the equivalency of heat to mechanical power, or *vis viva*." The effect of the heat thus liberated is that, in general, the meteorites entering our atmosphere are melted and frequently dissipated. One difficulty remains: it is asserted that some meteorites, examined immediately on their fall—a rare case—have been found intensely cold, as if they brought with them the low temperature of the depths of space.

In a notice on the "Intensity of Light during the Solar Eclipse of April, 1858," the author found that the light was reduced to about 1-150th of its normal quantity. He infers, in accordance with Mr. Dancer, that the circumference of the sun's disk gives out a very feeble radiation, as measured by a sensitive plate, in comparison with the central part. Mr. Dancer considers it indeed impossible in photographing the sun to obtain in the same image a satisfactory impression both of the central region and of the circumference.

It will be remembered that the greater part of Mr. Joule's chief researches were made a considerable number of years ago. There is, consequently, in this volume little which to the physicist will have the value of novelty. Nevertheless the memoirs here published, those especially on the mechanical equivalent of heat, have more than a mere historical value. Now attempts are being made to raise "caloric" from its grave, and reinstate the material theory of heat, the original memoirs of Mr. Joule will be important documents for reference.

The Neutral Didymium Molybdate and the Valence of Didymium.—Alph. Cossa.—The author has obtained the neutral didymium molybdate in crystals by simply fusing the amorphous molybdate at a very high temperature. These crystals are isomorphous with lead molybdate. Hence he considers that didymium oxide should be represented by the formula DiO.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 16, April 21, 1884.

On the Scale of Temperatures and on Molecular Weights.—M. Berthelot.—The author asks:—"In the midst of these incessant and progressive changes of the gases reputed as simple, under the influence of high temperatures what becomes of our conventions and our atomic hypotheses on the number of molecules,—hypotheses constructed solely according to data observed in the neighbourhood of the ordinary temperature? Will the constitution of the ultimate particles of our elementary bodies be henceforth arbitrarily simplified? The fundamental study of specific heats which have been lately invoked in support of these hypotheses tends to establish that heat, which dissociates compound molecules into their elements, acts in a similar manner to disaggregate the groups, doubtless very complex, which form the so-called elementary matters."

Optical Identity of the Crystals of the Herderite of Ehrenfriedersdorff and that of the State of Maine.—M. des Cloizeaux.—The nature of this paper appears sufficiently from its title.

Separation of Phosphoric Acid in Arable Soils.—M. de Gasparin.—The author admits the criticisms of M. Lechartier (*Comptes Rendus*, March 31, 1884), and shows by a letter addressed to M. Peligot that he had himself detected the error in his analytical method pointed out by M. Lechartier.

Boiling-Points of Oxygen, Air, Nitrogen, and Carbon Monoxide under the Atmospheric Pressure.—S. Wroblewski.—The boiling-point of perfectly pure oxygen is $-184°$, that of air $-192{\cdot}2°$, that of nitrogen $-194{\cdot}3°$. It is remarked that the elements of air do not separate when liquefied. The boiling-point of carbon monoxide containing 6 per cent of carbon dioxide is $-186°$. If we take the boiling-point of carbon dioxide at $-80°$, that of pure carbon monoxide will be $-193°$, or nearly the same as that of nitrogen. When these gases are evaporated in a vacuum the temperature descends a few degrees below $-200°$. Atmospheric air will be the refrigerator of the future.

On a Metallic Radicle.—P. Schützenberger.—It is generally supposed that an alloy if submitted to the action of oxidising or chlorinising reagents yields compounds corresponding to the constituent metals. The author has met with an alloy of platinum and tin which behaves in a different manner. If this alloy is treated with hydrochloric acid in a flask filled with hydrogen or carbon dinoxide a part of the tin is dissolved out as stannous chloride and there remains a soft body having the touch of graphite and composed of platinum, tin, chlorine, oxygen, and hydrogen. The chlorine is removed by prolonged washing, and there remains a body which when dried in a vacuum over sulphuric acid consists of $Pt_2Sn_3O_4H_2$.

Determination of the Vapour Densities of Glucinium Chloride.—MM. L. F. Nilson and Otto Pettersson.—If this compound is regarded as GlCl the specific gravity is $1{\cdot}385$, if as $GlCl_2$ $2{\cdot}770$, if as $GlCl_3$ it becomes $4{\cdot}155$, and if as Gl_2Cl_6 it will be $8{\cdot}310$. If Avogadro's law is applied to the values found the molecule of glucinium chloride is represented by $GlCl_2$ at temperatures between 686° and 812°. As regards the atomic weight of glucinium the laws of Dulong and of Avogadro lead to contradictory results—the first known case for a metallic element. According to Avogadro's law Gl = 9·1, a value which agrees well with the periodic system of the elements.

On the Curves of the Solubility of Salts.—A. Etard.—The solubility of salts is generally represented by curves showing the quantity of the salt which can be dissolved in 100 parts of water. For these the author substitutes others, showing the quantity of anhydrous salt contained in 100 parts by weight of the solution. In this method of representing solubilities all the results are comprised between 0° and 100° the curves are more susceptible of comparison and of chemical interpretation, as they give, for each temperature, the centesimal composition of the liquid, *i.e*, an analysis comparable, in all points, to ordinary chemical analyses, and which admits of a rapid calculation of the relation between the salt and the water of solution. Whatever may be the nature of the salt employed its solubility within a certain interval of temperature is always represented by a right line forming a greater or smaller angle with the axis of the temperatures. This right line represents the normal phenomenon of solubility for a certain state of equilibrium between the water and the dissolved salt considered in the anhydrous or hydrated state. But as the temperature continues to rise there arrives a point where the original equilibrium can no longer subsist. A new state becomes established and during the larger or smaller interval of temperature within which this change is effected, the right line is deflected. But as soon as a new equilibrium is established the solubility again becomes proportional to the temperature, and we again find a right line.

The Bark of Zanthoxylum Caribæum and its Chemical Composition.—MM. Heckel and Schlagdenhauffen.—In this bark the authors have discovered a compound, $C_{12}H_{24}O$, and a poisonous nitrogenous base the composition of which they have not determined. Nitric acid gives it a bright red colour. The nitric solution, evaporated to dryness on the water-bath, and treated with a drop of stannous chloride, does not turn violet, like brucine.

Sterilisation of Liquids by means of Papin's Digester.—L. Heydenreich.—It is necessary that the digester should be exhausted of air previous to heating.

Cosmos les Mondes.
No. 11, March 15, 1884.

Improvements in the Manufacture of Sulphuric Acid.—To obtain pure monohydrated acid M. G. Lunde (Lunge ?), of Zurich, utilises the property of sulphuric acid, at 98 per cent, of giving, when cooled below 0°, crystals of the monohydrated acid. He finds that the commercial acids of 96 and 97 per cent, when refrigerated, present the phenomenon of superfusion, and in this condition is readily induced to crystallise by the addition of a crystal of the monohydrated acid. He commences by preparing a small quantity of crystalline monohydrated acid, by refrigerating acid at 98 per cent down to − 10°. This small quantity of crystals serves then to determine crystallisation in acids at 96 and 97 per cent previously cooled down to − 10°. The crystals of pure monohydrated acid, thus obtained are drained. The purity of the acid obtained depends on the number of successive crystallisations which it has undergone and on the temperature at which it has been drained. If this has been done at too low a point there is only a very small quantity of mother-liquor, which, consequently, cannot carry away all the impurities.

The Harmlessness of Lead. — An anonymous pamphlet which has appeared at Leipzig contends that leaden water pipes are perfectly safe.

Combination-Heats of the Ammonium Compounds.—Dr. D. Tommasi.—The author gives in parallel columns tables of the combination heats as found experimentally and as calculated according to his law, showing generally a close agreement.

No. 12, March 22, 1884.

The Cholera and Cats.—According to the *Journal d'Hygiene* cats in India are sometimes attacked by choleraic disease, and may communicate it to human beings.

Death of M. Boutigny.—This distinguished physicist, well-known for his researches on the spheroidal state of liquids, died on March 17th, in his 86th year.

The Bethelot-Tommasi Incident.—At the session of the Academy, March 18th, M. Tommasi requested M. Bertrand, the Perpetual Secretary, to present to the Academy a certain memoir. M. Bertrand remarked that the debate between the two chemists threatened to become indefinitely prolonged, and that before inserting M. Tommasi's memoir in the *Comptes Rendus* he should consider it useful to submit the paper to some chemist connected with the Academy. So saying he handed the document to M. Berthelot! As a consequence easy to be foreseen the memoir has not appeared.

The Law of Thermic Substitution Constants.—Dr. D. Tommasi.—In a former note laid before the Academy, the author has shown by various instances that his law is applicable not merely to the salts of mercury and lead, but to all soluble salts without exception. M. Berthelot finds nothing to object to as far as the salts of magnesium, zinc, copper, lead, &c., are concerned, but he points out as exceptions mercury, bromide, cyanide, and acetate. As regards the first of these cases M. Tommasi argues that the assumed formation-heat of mercury bromide, 48·5, is not exact, and that a re-determination is required. The discrepancy as regards mercury cyanide is due, not to the dissociation of the dissolved mercuric cyanide, but to the partial decomposition of the potassium cyanide, which the author employed in calculating the combination-calories of dissolved mercuric cyanide. As for mercuric acetate, the number of calories disengaged on its formation, according to M. Bethelot (6), is evidently too small and cannot be admitted. To this memoir is appended a table of the combination-heat of the compounds of hydroxyl-ammonium as predicted according to the law of M. Tommasi.

No. 13, March 29, 1884.

M. Hallez, a naval lieutenant, stationed at Madagascar sends to the "International Society of Electricians" an account of the daily storms which rage there. The soil of the island is very ferruginous, and in approaching it the compass undergoes considerable and totally abnormal variations. Hence it is suggested that Madagascar may be an enormous magnet.

Combination-Heats of the Compounds of Ethyl-ammonium.—Dr. D. Tommasi.—A table of combination-heats as predicted by the author's law.

No. 14, April 5, 1884.

Combination-Heats of the Compounds of Trimethyl-ammonium.—Dr. D. Tommasi.—The author gives the combination-heats of trimethyl-ammonium sulphate, carbonate, and acetate as calculated and as found experimentally, and a series of heats as calculated but not yet verified experimentally.

MEETINGS FOR THE WEEK

TUESDAY, 10th.—Royal Medical and Chirurgical, 8.
—— Photographic, 8.
WEDNESDAY, 11th.—Geological, 8.
—— Microscopical, 8
THURSDAY, 12th.—Royal, 4.30.
FRIDAY, 13th.—Royal Institution, 8. "Researches on Liquefied Gases," by Professor Dewar, at 9.
—— Astronomical, 8.
—— Quekett Microscopical Club, 8.
SATURDAY, 14.—Physical, 3. "On the Velocity of Sound in Tubes,' by D. J. Blaikley. "On a New Apparatus for Colour Combinations," by H. H. Hoffert.

THE CHEMICAL NEWS.

Vol. XLIX. No. 1281.

β-NAPHTHAQUINONE.*

By CHARLES E. GROVES, F.R.S.

In a preliminary notice read before the Society some time ago (Chemical News, vol. xlv., p. 267) on methods of preparing β-naphthaquinone, with especial reference to the value of "β-naphthol orange," the sodium salt of the diazo-sulphonic acid, $OH.C_{10}H_6.N_2.C_6H_4.SO_3H$, recommended by Liebermann as the most convenient source from which to prepare the quinone, the author mentioned that he had carefully repeated Liebermann's experiments, and although he could fully corroborate his statements as to the results obtained, he did not agree with him as to the value of the method for preparing β-napthaquinone.

In the present paper full details are given of the processes for preparing amido-β-naphthol hydrochloride from the "β-orange" by reduction with stannous chloride and also with alkaline sulphides, alluded to in the preliminary notice. Although interesting theoretically, this process is far inferior in simplicity and economy to the one originally proposed by Stenhouse and the author (*Journ. Chem. Soc.*, 1877, ii., 47; and 1878 *Trans.*, 415), which consisted in preparing nitroso-β-naphthol from β-naphthol by the action of nitrosyl sulphate, and then reducing the barium derivative of this by ammonium sulphide. At the present time nearly pure sodium nitrite is made on the large scale for use in the coal-tar colour industry, and it is obviously an advantage to substitute a commercial article like this for nitrosyl sulphate, which has to be made in the laboratory. The method of preparing the nitroso-naphthol now adopted by the author consists in pouring a dilute solution of sodium β-naphthol and sodium nitrite in the proper proportions into dilute sulphuric acid, collecting the yellow precipitate, and purifying it by dissolving it in dilute soda solution, and precipitating it as sodium nitroso-β-naphthol by the addition of more soda, the sodium derivative being but sparingly soluble in solutions containing 2 to 3 per ct. of NaHO. This sodium compound, when introduced in the moist state into a solution of stannous chloride in hydrochloric acid, is at once converted into amido-β-naphthol hycrochloride; care, however, must be taken to avoid any great excess of the stannous salt, otherwise amido-β-naphthol stanno-chloride will be formed instead of the simple hydrochloride.

β-Naphthoquinone.—In order to convert the amido-derivative into the quinone it is better to employ ferric chloride as the oxidising agent instead of the chromic mixture formerly recommended (*loc. cit.*), as it can be used in considerable excess, and allowed to remain in contact with the quinone for some time without altering it, whereas, with chromic mixture, it soon becomes altered and acquires a brown colour. When a dilute solution of amido-β-naphthol hydrochloride is poured into a solution of ferric chloride slightly in excess of the proportion indicated by the equation—

$$OH.C_{10}H_6.NH_3Cl + Fe_2Cl_6 + H_2O = C_{10}H_6O_2 + 2FeCl_2 + NH_4Cl + 2HCl,$$

the mixture becomes momentarily darker in colour, and immediately afterwards deposits the quinone in orange-yellow microscopic needles: these have to be carefully washed, and dried at a gentle heat in an atmosphere free from acid fumes, which would darken the quinone from formation of dinaphthyl-diquinhydrone. β-naphthaquinone obtained in this way is pure, and of a deep golden colour, the yield being from 70 to 72 per cent of the amido-hydrochloride employed. As already pointed out, this process has two advantages over Liebermann's; firstly, it is much simpler; and secondly, the cost for raw material to produce a given weight of the quinone is reduced to about one-fifth.

Nitro-β-naphthaquinol, $C_{10}H_5(NO_2)(OH)_2$.—In a former paper (*loc. cit.*) it was mentioned that two compounds, apparently nitro-β-naphthaquinol and amido-β-naphthaquinol, were obtained by the action of hydriodic acid and phosphorus on the nitroquinone. They are, however, more conveniently prepared by the employment of stannous chloride as the reducing agent. When moist nitro-β-naphthaquinone is introduced into a somewhat dilute solution of stannous chloride (containing 4 to 5 per cent of tin) in the proper proportions, a considerable portion of the nitro-derivative dissolves, forming a deep red liquid; but in a few minutes it again becomes paler, and the amido-quinol separates in the crystalline state. It is almost insoluble in water, but may be crystallised from alcohol or benzene, when it forms brilliant red scales, quite different from the substance of the same composition obtained by Korn from nitro-β-naphthaquinon-anilide (*Berichte*, 17, 909).

Amido-β-naphthaquinol.—Nitro-β-naphthaquinone is converted into the amido derivative by submitting it to a more energetic reducing action, such as tin and hydrochloric acid, or a hot concentrated solution of stannous chloride. It is far better, however, to convert it first into the nitro-β-naphthaquinol, and to mix the crystals while still moist with finely-divided tin—such as is obtained by precipitation—and strong hydrochloric acid. On gently heating the mixture in a water-bath a violent reaction sets in, which, if the quantity operated on is large, must be moderated by plunging the beaker into cold water. The red colour rapidly disappears, and, on cooling, the amido-β-naphthaquinol hydrochloride is deposited in the crystalline state, and may be purified by re-crystallisation from hot water, when it forms pale yellow prisms. Like the amido-β-naphthol-compound, it is quickly oxidised on exposure to the air.

In conclusion, the author drew attention to the fact that although in a paper published in conjunction with the late Dr. Stenhouse he had mentioned the production of amido-β-naphthaquinone by the action of reducing agents, and more recently in a notice in the *Berichte* especially addressed to Prof. Liebermann, he had stated that he was engaged in an investigation "of nitro-β-naphthaquinone and the products obtained from it by the action of reducing agents" (*Berichte*, 14, 1659), a student in the "Org. Laboratorium d. tech. Hochschule," working under Prof. Liebermann's direction, has recently published a note in which he describes the reduction of nitro-β-naphthaquinone to amido-β-naphthaquinone without the slightest reference to its having been already done.

* Abstract of a Paper read before the Chemical Society.

OXY-CELLULOSE AND PHENYL-HYDRAZINE.

By C. F. CROSS and E. J. BEVAN.

In a recent number of the *Berichte Deut. Chem. Gesell.* (1884, p. 572), there is a paper by Fischer on the reactions of the salts of phenyl-hydrazine with aldehyds and ketones of both the aromatic and fatty groups. Amongst the reactions specially described are those of the aldehydic sugars, but no mention is made of experiments with the more complicated members of the carbohydrate group, *e.g.*, the cellulose and their immediate derivatives. We are therefore extending this reaction, which appears to be generally characteristic of the aldehyds and ketones, to the examination of the large group of the celluloses and their derivatives. Thus far we have found that the oxy-celluloses described by Witz and ourselves* give a deep

* *Bull. Soc. Ind. Rouen*, 1883, 169 and 240; *Chem. Soc. Journ.*, Jan., 1883, 22.

yellow colouration when warmed with a solution of the hydrochloride of the base; lignose, on the other hand, a dull yellow, contrasting strongly with the bright yellow which it gives with aniline sulphate. These reactions are characteristic, and we recommend them to the attention of those who are working in this field of research.

THE ACTION OF ARSENIOUS ANHYDRIDE UPON GLYCERIN.

By HERBERT JACKSON.

Following out a suggestion made to me by Professor Bloxam, I have recently examined the action which takes place when glycerin is saturated with As_2O_3. It is stated in several books that glycerin is the best solvent for As_2O_3, but the reason of this has, so far as I am aware, never been pointed out. I found that a considerable quantity of water was given off when anhydrous glycerin was treated with dry As_2O_3, and I directed my attention in the first place to the determination of the amount of water evolved when a weighed quantity of glycerin was treated with excess of As_2O_3. Some preliminary experiments had shown that the As_2O_3 would be in sufficient excess if used in the proportion of 1·5 parts of As_2O_3 to 1 part of glycerin. I found considerable difficulty in obtaining constant results in the determination of the water; but the mean of several experiments (viz. 25·5 grms. of glycerin gave 8·2 grms. of water) indicated that the amount of As_2O_3 required to saturate the glycerin was at least equal in weight to the glycerin employed. The next experiments were arranged to determine the maximum quantity of As_2O_3 which could be made to combine with glycerin. For this purpose different proportions of glycerin and As_2O_3 were taken and placed in stout hard glass tubes, the ends of which were then sealed, and the tubes with their contents were heated in an air-bath for two hours at a temperature of 250° C.

It was found that in all cases where the amount of As_2O_3 had been greater than that indicated by the previous experiments, (viz., 1 part of As_2O_3 to 1 part of glycerin), some of the As_2O_3 crystallised out as the tubes cooled. Some blackening of the contents was noticed in each instance; this was found on examination to be due to arsenic from reduction of a little As_2O_3. After these experiments I made some more determinations of the amount of water evolved when a weighed quantity of glycerin was treated with As_2O_3, and of the weight of As_2O_3 required to fully saturate it. The mean of these experiments gave the following result:—14·45 grms. of glycerin required for saturation 15·98 grms. of As_2O_3 and gave off 4·57 grms. of water, or nearly; 184 parts (2 equivalents) of glycerin require 198 parts (1 equivalent) of As_2O_3, and evolve 54 parts (3 equivalents) of water, represented by the equation—

$$2C_3H_5(OH)_3+As_2O_3=2C_3H_5AsO_3+3H_2O.$$

The mean of the analyses of the products obtained in the last experiments gave the following result:—0·2121 grm. of the compound contained 0·1225 grm. of As_3O_3; 0·2121 grm. of $C_3H_5AsO_3$ contains theoretically 0·125 grm. As_2O_3. These experiments prove that As_2O_3 and glycerin react together to form normal glyceryl arsenite or the arsenious ether of glycerin, in the manner represented by the above equation. This compound is a colourless, transparent, vitreous solid, very deliquescent, and easily decomposed by water into glycerin and As_2O_3. It is entirely soluble in absolute alcohol, and is left unchanged when the alcohol is driven off by evaporation. It is also freely soluble in glycerin, as would be expected. It becomes soft at 100° C., and can be poured easily when the temperature reaches 200° C. When quite dry it appears to be stable at the boiling-point of glycerin, 290° C., but is decomposed above that temperature.

King's College, Chemical Laboratory,
London, June 4, 1884.

MOLECULAR COMPOUNDS OF CALCIUM.

By CHARLES W. FOLKARD, Assoc. R.S.M.

In an attempt to prepare and isolate the particular sulphide of calcium which is capable of combining with bisulphide of carbon vapour, a series of compounds were obtained, which, so far as I am aware, have not yet been described, and they are the more interesting inasmuch as bleaching-powder appears to have a somewhat analogous constitution.

On passing a mixture of dry hydrogen and sulphuretted hydrogen (the gas obtained by acting on ferrous sulphide with dilute sulphuric acid) over hydrate of calcium for some hours until no more gain of weight is observed, a grey powder is obtained consisting of CaH_2O_2 and H_2S in a very feeble state of combination, the CaH_2O_2 increasing in weight about 32 to 33·5 per cent. This corresponds nearly to the equation—

$$4CaH_2O_2+3H_2S=4CaH_2O_2.3H_2S.$$

On passing coal-gas over this compound H_2S is evolved, and by raising the temperature to 100° C. H_2O is eliminated and a grey green salt is left.

$$4CaH_2O_2.3H_2S = \begin{cases} CaH_2O_2 \\ CaH_2O_2 \\ CaO.H_2S \\ CaO.H_2S \end{cases} + H_2S + 2H_2O.$$

The grey green compound by a gentle heat in a stream of coal-gas loses H_2O, leaving a yellowish white salt of the composition—

$$\begin{cases} CaH_2O_2 \\ CaH_2O_2 \\ CaO.H_2S \\ CaS \end{cases}$$

By a red heat (air being excluded) $2H_2O$ are eliminated, leaving a compound of the formula—

$$\begin{cases} 2CaO \\ CaO.H_2S \\ CaS \end{cases}$$

which, when ignited in air, glows and burns like tinder, $CaSO_4$ being formed.

These bodies are probably molecular compounds of hydrate and oxy-hydrosulphide of calcium, and if this be the case bleaching-powder may have a constitution represented by the formula—

$$2CaH_2O_2+Cl_2 = \begin{cases} CaH_2O_2 \\ CaO.Cl_2.H_2O \end{cases}$$

it being well known that the lime absorbs only 50 per cent of its weight of chlorine, which agrees fairly well with the above. It is unfortunate, however, from a manufacturing point of view that there is apparently no chlorine analogue of the sulphuretted compound—

$$\begin{cases} 4CaH_2O_2 \\ 3H_2S \end{cases}$$

otherwise there would be a possibility of forming a "bleach" containing 36 per cent of available chlorine.

The above compounds are rational, and their constitution may be expressed by graphic formulæ in which sulphur is a hexad (the molecules of CaH_2O_2 being separate).

The grey green salt was analysed with the following results:—

	Theory.	Obtained.	
Ca_4	48·8	48·5	
S_2	19·5	18·9	
$(H_2O)_3$	16·5	16·7	
O_2 for Ca_2	9·7	10·0	(calculated from Ca and S found).
H_2O not expelled by red heat	5·5	5·9	(by difference).
	100·0	100·0	

Chiswick, W., May 29, 1884.

ON THE SEPARATION AND DETERMINATION OF LIME EVEN IN THE PRESENCE OF A LARGE EXCESS OF ALUMINA MAGNESIA, FERRIC OXIDE, AND PHOSPHORIC ACID.

By M. ANTONY GUYARD.

Alumina, ferric oxide, lime, and the phosphates of these bases are, as is known, soluble in ammoniacal ammonium citrate. The author finds that on employing as nearly as possible only the quantity of ammonium citrate necessary to keep these bodies in a state of perfect solution, the lime is easily and completely precipitated by means of ammonium oxalate. The calcium oxalate thus obtained may be ignited and weighed directly.

When the mixture, as is observed in the analysis of soils, contains a little soluble silica, this is partially precipitated, and carries down with it a little iron and alumina, and it is necessary to purify the precipitate before proceeding with the operation.

The presence of magnesia does not interfere with the direct determination of the lime as proposed. It is merely necessary to effect the precipitation at 70° to 80°, so that the ammoniacal magnesium phosphate which would be thrown down in the cold may remain in solution.

After the separation of the lime nothing prevents the determination of the magnesia by means of phosphoric acid, or of phosphoric acid by means of magnesia. The simple process just described can receive a number of applications in analysis. It is more convenient than the usual method, which consists in transforming the mixtures of lime, magnesia, alumina, ferric oxide, and phosphoric acid, into acid acetates, and is much more accurate.

Calcium oxalate is soluble in free acetic acid, even when dilute, in a quantity proportional to the quantity of free acetic acid and of acetates present. To obtain a complete precipitation of the lime it is necessary to add sufficient ammonium oxalate to convert the acetates into oxalates. Even then the precipitation of the lime is not perfect.—*Bulletin de la Société Chimique.*

SPONTANEOUS DECOMPOSITION OF EXPLOSIVE GELATIN.

By CHARLES E. MUNROE, S.B. (Harv.).

Several instances of the decomposition of explosive gelatin, on keeping or after long exposure to moderate temperatures, have been reported, but I have yet met with but one of these cases in which the products of the decomposition have been stated. Genl. H. L. Abbot, in a prefatory note to Addendum I. Report on Submarine Mines, states that "all the samples of the explosive gelatin remaining on hand after the trials detailed in the Report have undergone spontaneous decomposition, separating into cellulose and free nitro-glycerin with the copious evolutions of nitrous fumes. This change occurred during the winter and spring of the current year (1881—1882), and was not caused by any exposure to high temperatures while in store."

A case of spontaneous decomposition of a small amount stored freely exposed to the air, in a room of fairly even temperature and dryness, has occurred under my own observation. The camphorated explosive gelatin was wrapped in paraffin paper, and then in light brown Manilla paper, and laid on the shelf. After something more than one year's exposure it was found, in the early winter, to be giving off nitrous fumes (which had stained and attacked the wrapping paper), and to have shrunk considerably in volume, while the outside of the paper was covered with congeries of fine crystals. The odour of camphor was still quite strong. The mass was immediately put into a vessel of water. It was found to be friable, and, after a short immersion, disintegrated. The camphor odour soon disappeared, and the water became of a straw colour, gave a strong acid reaction, and showed traces of nitrous acid, but no nitric acid. On evaporation of the filtered liquid, oxalic acid crystallised out in quantity, and on evaporation of the "mother-liquor" on the water-bath a sugar-like mass was obtained, which gave the glucose reaction with Fehling's solution. The paraffin was regained unchanged, and the paper was recovered, but in a flocculent condition, and with the colour bleached from the brown. Careful search failed to reveal the presence of glycerin, nitro-glycerin, or gun-cotton. The cellulose from the gun-cotton could not well be detected (if it existed) in the presence of so much flocculent cellulose from the paper. In reporting these observations I am not unmindful of the fact that some changes may have taken place during immersion, but it can easily be understood why I preferred it in that position.

The results obtained by De Luca in his "Researches on the Spontaneous Decomposition of Gun-Cotton" (*Comptes Rendus*, 59, 487, Sept. 12, 1847) are interesting in this connection. Gun-cotton decomposes most rapidly when heated to 50° on a water-bath, next by direct sunlight, more slowly by diffused light, and very slowly in darkness. The gun-cotton first shrinks to one-tenth of its original volume, next it begins to become gum-like and sticky, then it swells; during all these phases it gives off nitrous fumes, but especially during the last. For the fourth phase the gas ceases to be evolved, and the mass becomes brittle, and of a light colour like sugar. The products are nitrous compounds, with formic and acetic acids in the state of a gas, and an amorphous, porous, sugar-like body, almost entirely soluble in water, and containing an abundance of glucose, gummy matter, oxalic acid, a small quantity of formic acid, and a new acid of which he obtained the lead and silver salts for later examination. From 100 grains of gun-cotton he obtained about 14 grains of glucose.

In discussing the stability of nitro-glycerin (which is the other component of explosive gelatin), A. Brull, in "Etudes sur la Nitro-glycérin et la Dynamite," fig. 26, 1875, says, "Nitro-glycerin which retains traces of acid is not stable. In general the decomposition is extremely slow and tranquil. It disengages at first nitrous fumes, and the liquid takes a greenish colour; then it generates nitrogen protoxide, carbon dioxide, and crystals of oxalic acid; and after some months the entire mass is found to be converted into a greenish, gelatinous mass, composed of oxalic acid, water, and ammonia. Sometimes, if the temperature is quite high,—if, for example, the nitro-glycerin is heated by the sun.—the decomposition is more active. Very rarely it causes an explosion.

The source of difficulty, then, seems to be in the presence of free acid, and this will probably be found in the gun-cotton used, for it is difficult to purify soluble gun-cotton completely.—*Journal of the American Chemical Society.*

SAMARSKITE, FROM BERTHIER COUNTY, QUE.*

By J. T. DONALD, M.A.

In September last Mr. David Aikman of this city sent me for examination a specimen of a hard, heavy, brownish black mineral which he had found in the township of Brassard, County of Bertheir, Que. On examining this mineral with the blowpipe I thought it must be either columbite or tantalite. Its specific gravity 5·305 (or, from a fragment sent to Mr. J. H. Burland, 5·1142) led to the belief that it was the former. At the time I could not

* Read before the Natural History Society, Montreal, Jan., 1884.

learn that this mineral had hitherto been found in Canada, but on writing to Mr. C. C. Hoffman, Chemist and Mineralogist to the Geological Survey, I learned that a specimen had been obtained from the very same locality by officers of the Survey, and had been analysed by Mr. Hoffman, whose analysis showed it to be the species Samarskite.

Mr. Hoffman published a report of his analysis in the *American Journal of Science* early last year, and in his report (as yet unpublished) to the Director of the Survey, writes as follows:—

"*Samarskite.*

"This interesting mineral—not hitherto met with in Canada—was found just beyond the north-western limits of the Township of Brassard, County of Berthier, P.Q.

"It consisted of irregular-shaped fragments without the slightest indication of crystalline form; lustre, submetallic, shining; colour, brownish-black, almost black; in parts iridescent; opaque even on the thinnest edges; brittle; fracture, uneven; streak, greyish brown; hardness, about 6; fuses between 4 and 4·5; specific gravity, 4·9478. In the closed tube decrepitates and gives off a little slightly acid water. Readily and completely decomposed by heating with concentrated sulphuric acid. Analysis gave—

Columbic acid .. .. } Tantalic acid .. .. }	55·41 *
Tungstic acid	—
Stannic acid..	0·10
†Yttrium oxide	14·34
†Cerium oxide	4·78
Uranium oxide (UO_3)	10·75
Manganous oxide	0·51
Ferrous oxide	4·83
Lime	5·38
Magnesia	0·11
Potash	0·39
Soda	0·23
Fluorine..	trace
Water	2·21
	99 04

* Apparently in great part, if not almost entirely, columbic acid.
† The presence or absence of other members of this group was not ascertained.

"A gramme of the finely pulverised mineral, decomposed by heating with sulphuric acid, with careful exclusion of air, decolourised an amount of potassium permanganate corresponding to 4·79 per cent ferrous oxide. The water was expelled by ignition, and collected in a chloride of calcium tube."

Mr. Aikman's specimen is, in physical characters, very similar to that analysed by Mr. Hoffman, differing only in the higher specific gravity. Mr. Aikman informs me that this mineral is not at all rare in the locality mentioned; it was seen scattered through the gneiss in several places in irregular patches from six to eight inches in length. It is interesting to note that this mineral, containing so large a proportion of the metals columbium, tantalum, uranium, cerium, and yttrium, is so abundant in the locality cited.—*Canadian Record of Natural History and Geology.*

Conditions proper for Accelerating the Oxidation of Drying Oils.—A. Livache.—The author finds that whilst an ordinary drying oil containing lead dries in 24 hours, a similar oil containing manganese dries under the same conditions in 5 to 6 hours. Copper, zinc, cobalt, nickel, iron, chrome, &c., prolong the time of drying to 36 to 48 hours. In practice he takes an ordinary lead oil, adds to it dry manganese sulphate in fine powder, and agitates for some time in the cold. The manganese is entirely substituted for the lead, and the oil obtained, freed from dregs by simple decantation, possesses an extreme drying power.—*Les Mondes*, No. 14.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

ZIRCONIUM.

The atomic weight of zirconium has been determined by Berzelius, by Hermann, and by Marignac. Berzelius† ignited the neutral sulphate, and thus ascertained the ratio in it between the ZrO_2 and the SO_3. Putting SO_3 at 100, he gives the following proportional quantities of ZrO_2:—

75·84
75·92
75·80
75·74
75·97
75·85

Mean 75 853 ± 0·023

Hence Zr = 89·255 ± 0·039; or, if O = 16, then Zr = 89·461.

Hermann's‡ estimate of the atomic weight of zirconium was based upon analyses of the chloride, concerning which he gives no details or weighings. From sublimed zirconium chloride he finds Zr = 831·8, when O = 100; and from two lots of the basic chloride $2ZrOCl_2.9H_2O$, Zr = 835·65 and 851·40 respectively. The mean of all three is 839·62; whence, with modern formulæ and O = 15·9633, Zr becomes = 89·354.

Marignac's results‖ were obtained by analysing the double fluoride of zirconium and potassium. His weights are as follows:—

1·000	grm. gave	0·431	grms. ZrO_2 and	0·613	grm. K_2SO_4.
2·000	,,	0·864	,,	1·232	,,
0·654	,,	0·282	,,	0·399	,,
5·000	,,	2·169	,,	3·078	,,

These figures give us three ratios. A, the ZrO_2 from 100 parts of salt; B, the K_2SO_4 from 100 parts of salt; and C, the ZrO_2 proportional to 100 parts of K_2SO_4:—

A.	B.	C.
43·100	61·300	70·310
43·200	61·600	70·130
43·119	61·000	70·677
43·380	61·560	70·468
Mean 43·200 ± 0·043	61·365 ± 0·094	70·396 ± 0·079

From A	Zr = 89·775 ±	0·216
,, B	,, 91·408	0·437
,, C	,, 90·476	0·138
General mean ..	,, 90·328	0·113

Or, if O = 16, Zr = 90·536.

Combining with Berzelius's work we get this result:—

Berzelius	Zr = 89·255 ±	0·039
Marignac	,, 90·328	0·113
General mean ..	,, 89·367	0·037

Or, if O = 16, Zr = 89·573.

These figures need little criticism. They show conclusively that the atomic weight of zirconium ought to be redetermined. Probably the method employed by Berzelius was the best with respect to manipulation, while, on the

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 4, 126. 1825.
‡ *Journ. f. Prakt. Chem.*, 31, 77. *Berz. Jahresb.*, 25, 147.
‖ *Ann. Chim. Phys.*, (3), 60, 270 1860.

other hand, it is likely that Marignac worked with purer material. Hermann's experiments could hardly have yielded certain results, since the zirconium chloride might so easily become contaminated with traces of moisture and thence of oxygen.

THORIUM.

THE atomic weight of thorium has been determined from analyses of the sulphate, oxalate, formate, and acetate, with widely varying results. The earliest figures are due to Berzelius,* who worked with the sulphate, and with the double sulphate of potassium and thorium. The thoria was precipitated by ammonia, and the sulphuric acid was estimated as $BaSO_4$. The sulphate gave the following ratios in two experiments. The third column represents the weight of ThO_2 proportional to 100 parts of $BaSO_4$:—

0·6754 grm. ThO_3 = 1·159 grms. $BaSO_4$.	Ratio 58·274	
1·0515 ,, 1·832 ,,	,, 57·396	

The double potassium sulphate gave 0·265 grm. ThO_2, 0·156 grm. SO_3, and 0·3435 K_2SO_4. The SO_3, with the Berzelian atomic weights, represents 0·4537 $BaSO_4$. Hence 100 $BaSO_4$ is equivalent to 58·408 ThO_2. This figure, combined with the two previous values for the same ratio, give a mean of 58·036 ± 0·214. Hence ThO_2 = 269·940 ± 0·997.

From the ratio between the K_2SO_4 and the ThO_2 in the double sulphate, ThO_2 = 268·284.

In 1861 new determinations were published by Chydenius,† whose memoir is accessible to me only in an abstract‡ which gives results without details. Thoria is regarded as a monoxide, ThO, and the old equivalents (O = 8) are used. The following values are assigned for the molecular weight of ThO, as found from analyses of several salts:—

From Sulphate.	From K. Th. Sulphate.
66·33	67·02
67·13	
67·75	
68·03	

Mean 67·252 ± 0·201

From Acetate.	From Formate.	From Oxalate.
67·31	68·06	65·87 } Two results
66·59	67·89	65·95 } by Berlin.
67·27	68·94	65·75
67·06	———	65·13
68·40	Mean 68·297 ± 0·219	66·54
		65·85
Mean 67·326 ± 0·201		Mean 65·85 ± 0·123

We may fairly assume that these figures were calculated with O = 8, C = 6, and S = 16. Correcting by the values for these elements which have been found in previous chapters, ThO_2 becomes as follows:—

From sulphate	ThO_2 = 268·584	± 0·803
,, acetate	,, 268·735	0·805
,, formate	,, 272·586	0·877
,, oxalate	,, 262·804	0·493

The single result from the double potassium sulphate is included with the column from the ordinary sulphate, and the influence of the atomic weight of potassium is ignored.

Chydenius was soon followed by Marc Delafontaine, whose researches appeared in 1863.‖ This chemist especially studied thorium sulphate; partly in its most hydrous form, partly as thrown down by boiling. In $Th(SO_4)_2.9H_2O$, the following percentages of ThO_2 were found:—

45·08
44·90
45·06
45·21
45·06

Mean 45·062 ± 0·0332

Hence ThO_2 = 263·637 ± 0·256.

The lower hydrate, $2Th(SO_4)_2.9H_2O$, was more thoroughly investigated. The thoria was estimated in two ways; first, (A), by precipitation as oxalate and subsequent ignition; second, (B), by direct calcination. These percentages of ThO_2 were found:—

52·83	A.
52·52	
52·72	
52·13	
52·47	B.
52·49	
52·53	
52·13	
52·13	
52·43	
52·60	
52·40	
52·96	
52·82	

Mean 52·511 ± 0·047

Hence ThO_2 = 266·025 ± 0·363

In three experiments with this lower hydrate the sulphuric acid was also estimated, being thrown down as barium sulphate after removal of the thoria:—

1·2425 grms. gave 0·400 SO_3.	(1·1656 grms. $BaSO_4$.)	
1·138 ,, 0·366 ,,	(1·0665 ,,	)
0·734 ,, 0·2306 ,,	(0·6720 ,,	)

The figures in parenthesis are reproduced by myself from Delafontaine's results, he having calculated his analyses with O = 100, S = 200, and Ba = 857. These data may be reduced to a common standard, so as to represent the quantity of $2Th(SO_4)_2.9H_2O$ equivalent to 100 parts of $BaSO_4$. We then have the following results:—

106·597
106·704
109·226

Mean 107·509 ± 0·585

Hence ThO_2 = 259·555 ± 2·725

Delafontaine seems himself to have calculated from the ratio between the percentages of SO_3 and ThO_2; whence, with our revised values for S, Ba, and O, ThO_2 = 262·643.

Delafontaine's work was soon confirmed by Hermann,* who published a single analysis of the lower hydrated sulphate, as follows:—

ThO_2	52·87
SO_3	32·11
H_2O	15·02
	100·00

Hence, from the ratio between SO_3 and ThO_2, ThO_2 = 263·030. Probably the SO_3 percentage was lost upon calcination.

The latest, and probably also the best determinations, are those of Cleve,† whose results, obtained from both the

* *Poggend. Annal.*, 16, 398. 1829. "Lehrbuch," 3, 1224.
† Kemisk undersökning af Thorjord och Thorsalter. Helsingfors, 1861. An academic dissertation.
‡ *Poggend. Annal*, 119, 55. 1863.
‖ *Arch. des Sci. Phys. et Nat.* (2), 18, 343.

* *Journ. f. Prakt. Chem.*, 93, 114.
† *K. Svenska Vet. Akad. Handlinger.* Bd. 2, No. 6 1874.

sulphate and the oxalate of thorium, agree admirably. The anhydrous sulphate, calcined, gave the subjoined percentages of thoria :—

62·442
62·477
62·430
62·470
62·357
62·366

Mean 62·423 ± 0·014

Hence $ThO_2 = 265·380 \pm 0·123$.

The oxalate was subjected to a combustion analysis, whereby both thoria and carbonic acid could be estimated. From the direct percentages of these constituents no accurate value can be deduced, there having undoubtedly been moisture in the material studied. From the ratio between CO_2 and ThO_2, however, good results are attainable. This ratio I put in a fourth column, making the thoria proportional to 100 parts of carbon dioxide :—

Oxalate.	ThO_2.	CO_2.	Ratio.
1·7135 grms.	1·0189 grms.	0·6736 grm.	151·262
1·3800 ,,	0·8210 ,,	0·5433 ,,	151·114
1·1850 ,,	0·7030 ,,	0·4650 ,,	151·183
1·0755 ,,	0·6398 ,,	0·4240 ,,	150·896

Mean 151·114 ± 0·053

Hence $ThO_2 = 265·357 \pm 0·104$.

There are now before us twelve estimates for the molecular weight of thoria. Two of these represent single experiments, and have no probable error attached to them; namely, the one due to Hermann, and the one deduced from Berzelius's $K_2SO_4 : ThO_2$ ratio. A third value, from Delafontaine's sulphuric acid estimations, has so high a probable error that it could be rejected without influencing the general mean. These three values might all be excluded without serious objection; but it is perhaps better to arbitrarily assign them equal weight, average them together, and give their mean the same probable error as that which attaches to Berzelius's $BaSO_4 : ThO_2$ series. This mean is indicated as "A" in the following combination :—

Value "A"	$ThO_2 = 263·623$	± 0·997
Berzelius	,, 269·940	0·997
Chydenius—Sulphate	,, 268·584	0·803
,, Acetate	,, 268·735	0·805
,, Formate	,, 272·586	0·877
,, Oxalate	,, 262·804	0·493
Delafontaine—Higher hydrate	,, 263·637	0·256
,, Lower ,,	,, 266·025	0·363
Cleve—Sulphate	,, 265·380	0·123
,, Oxalate	,, 265·357	0·104
General mean	,, 265·341	0·072

Hence Th = 233·414 ± 0·0725; or, if O = 16, Th = 233·951.

These values vary from those derived from Cleve's experiments alone only in the second decimal.

The following additional note has been communicated by the author :—

Since the foregoing chapter was first printed, a more exact determination of the atomic weight of thorium has been made by Nilson.* First, crystallised thorium sulphate (with $9H_2O$) was ignited. In six experiments the mean percentage of thoria thus obtained was 45·0905 ± 0·0019. Second, anhydrous thorium sulphate was ignited. In four experiments a mean percentage of thoria of 62·2975 ± 0·0008 was found.

From the first series of experiments, ThO_2 =
263·941 ± 0·039
,, second ,, ,, 263·959 0·053
General mean .. 263·947 ± 0·032

Hence, Th = 232·020 ± 0·032.

As Nilson is probably the first chemist to work with absolutely pure thorium compounds, this atomic weight determination must be regarded as supplanting all previous ones.

* *Berichte*, 15, 2527. 1882.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, June 5, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (June 19th).

The following certificates were read for the first time:—F. Broughton, F. J. Down, J. Hulme, F. G. Holmes, C. Thompson, W. F. Wyley.

Mr. C. E. Groves then read a paper "*On Beta-naphthaquinone*." An abstract of this paper appears on page 257.

The two following papers were then read by the Secretary :—

"*On a By-product of the Manufacture of Aurin* (Part II.)," by A. Staub and Watson Smith. In a previous paper it was shown that the product in question, phenyl-ortho-oxalic ether, was formed by the direct union of two molecules of phenol with one of anhydrous oxalic acid. The authors have prepared a perfectly pure specimen by repeated re-crystallisation from glacial acetic acid, and an analysis agrees with the formula $C_{14}H_{14}O_6$. Analogous compounds with α- and β-naphthols have been obtained, but no corresponding body could be obtained with resorcinol. The melting-point of the phenyl-ortho-oxalate was found to be 126° to 127°. When heated with strong sulphuric acid aurin is obtained. If phenol be present the yield of aurin is not increased. Only traces of formic acid are evolved during the reaction. The authors conclude that the ortho-phenyl-oxalate plays no part as an intermediate product in the formation of aurin. They also prove that not a trace of aurin is formed by the action of nascent carbon dioxide on phenol.

"*On Calcium Hydrosulphides*," by E. Divers and Tetsukichi Shimidzu, of Tokio. One part of lime, made by igniting precipitated calcium carbonate, is made into a thick paste by mixing with 4 parts of water; hydrogen sulphide is passed through, the lime gradually dissolves, more lime is added until a solution of the hydrosulphide, strong enough to crystallise when cooled, is obtained. The preparation of such a solution may take several days. Air must be completely excluded, and the process is facilitated by cooling. The solution having been prepared is allowed to settle at a slightly warm temperature, so that any crystals which have formed may be dissolved, and then decanted in an atmosphere of hydrogen sulphide. On cooling colourless prismatic crystals of $Ca(HS)_2,6H_2O$ separate out. They are very soluble in water and alcohol, and decompose when heated and when exposed to the air. Analyses are given proving the above composition. When this substance is treated with water or calcium hydrate, calcium hydroxy-hydrosulphide is formed, $CaHSHO,3H_2O$. This body crystallises in colourless four-sided prisms, slowly evolving hydrogen sulphide when exposed to the air. By gently heating the hydrosulphide in a current of hydrogen sulphide, calcium monosulphide mixed with some hydroxide was obtained

as a white amorphous solid. Carbon dioxide decomposes the calcium hydrosulphides, and the authors find that hydrogen sulphide decomposes calcium carbonate; so that carbon dioxide mixed with an excess of hydrogen sulphide may be passed through lime-water without causing a turbidity. Odling states that when calcium hydrosulphide is boiled with sulphur, hydrogen sulphide is liberated. Calcium pentasulphide is formed under these circumstances. The authors show that hydrogen sulphide bubbled through a cold dilute solution of pentasulphide effects the reverse reaction and re-forms the hydrosulphide. In conclusion, the authors have investigated the formation of thiosulphate from the hydrosulphide and the pentasulphide, and they conclude that in both cases it is not a direct oxidation, but that the hydrogen sulphide oxidises, and then by the reaction of its products forms the thiosulphate. They give the following equations:—

$$CaHSHO + 2O_2 + H_2S = CaS_2O_3 + 2H_2O.$$
$$CaS_5 + 2H_2O = CaHSHO + 3S + H_2S.$$

The hydrosulphide then reacts with oxygen and the hydrogen sulphide as above.

The Society then adjourned to June 19, when a ballot for the election of Fellows will be held and the following papers read:—"On the Magnetic Rotation of Chemical Bodies in Relation to their Composition and Constitution," by W. H. Perkin, F.R.S.; "On the Effect of High Temperature on Petroleum Hydrocarbons," by Drs. Armstrong and Miller; "On Nitrification" (Part III.), by R. Warington.

NOTICES OF BOOKS.

The Law and Practice of Patents. By Clement Higgins, Barrister-at-Law. London: William Clowes and Sons, Limited, 1884.

The legal changes that have been effected relating to patents for inventions, designs, and trade marks, at the commencement of this year, have occasioned the compilation and publication of a considerable number of treatises explanatory of the new Act. The aims of the various authors of these works are seemingly more or less alike, the analyses of this Act with such notes and citations as might on the one hand be of assistance to intending patentees in making their own application, or, on the other hand, to form standard legal treatises of professional value. The work before us evidently has been written with the view to its taking a place as a concise and comprehensive book of reference to this branch of law, and consequently the number of cases cited in order to render more clear and show the full bearing of the different sections of the Act are very numerous, and the amount of explanatory matter added in the form of notes is great. A special feature of the book is the introduction under the various sections of lengthy paragraphs of "Illustrations," being short accounts of points that have been made the subjects of legal dispute. These examples, which are numerous, together with the full analyses that the author gives of the sections of the new Act, will render the book an invaluable one for reference.

For the assistance of those who are not well versed in legal literature we think that when the next edition of this treatise is published it might be well to add a short note explaining the abbreviations employed in indicating the legal journals and other sources wherein the cases that are cited are reported.

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature, 2542-43 (1882-83). Tokio: Z. P. Maruya and Co.

The perusal of this little book by an Englishman is apt to flatter his vanity, especially if he knows anything of the order and extent of the courses of study laid down at any of our Universities or the text-books employed in the class rooms. The Japanese certainly do not, like their conservative neighbours the Chinese, regard Europeans as barbarians, or one-eyed mortals, judging by their liberal adoption of foreign educational schemes, and their having, to a certain extent, foreigners to lecture to them in a strange tongue. This exhibition of a liberal spirit is naturally only of a temporary character, arising from the eagerness of a nation living in a country rich in natural resources to utilise a knowledge of the arts and sciences to the material benefit of the race; and although we have here a calendar which, but for the names of the officials and pupils, might represent that of any of our own colleges, the changes that may take place in a few years' time when the English language is discarded and the present race of Japanese students have become philosophers, may necessitate an Oriental scholar to decipher the intricacies of the Japanese educational system.

The University of Tokio, with its four departments of Literature, Law, Medicine, and Science, offers to the studious youths of Japan ample facilities for obtaining a sound professional education, at least so far as the detailed statements of the courses of instruction that are herein given allow us to form an estimate; but however thorough and liberal this education code may appear to our eyes on paper, its suitableness to the intelligence of the people and the benefits likely to be derived from it will only be shown when the system has been worked for some years to come. To be admitted into this Institution the student must be over sixteen years of age and have passed through the courses of study in the Yobimon or preparatory school, or show on examination to have the necessary degree of proficiency to be able to take up profitably the more advanced studies. During the first year the subjects that are taught in each of the departments are of a general nature, serving to form a good foundation for the special courses that follow during the next three years. In the department of science eight such courses are established, of mathematics, physics, chemistry, &c., to any one of which the student is expected to give his whole attention. In the mathematical course during his three years study the student is required to read, in graduated order, such works as those of Todhunter, Williamson, Price, Frost, Salmon, and Boole, together with something of quaternions, elliptic functions, and the mathematical theory of electricity and magnetism. The student who selects physics as his branch of study is exercised in physical manipulations, the use of instruments of precision, and general laboratory work; in the third year electricity and magnetism are the principal studies, with practice in electric and magnetic measurements, telegraph testing, &c., and before the close of the term each student is required to undertake and carry out in the way of original research an investigation to be made the subject of his graduating thesis.

To the mining and metallurgical student every facility is offered for gaining that practical experience which alone makes his studies profitable. The metallurgical laboratory is supplied with small reverberatory, calcining, and several small retorting and smelting furnaces, a stamp battery, rock breaker, hydraulic jigger, &c.; quantities of ores from gold, silver, copper, and other mines being supplied for experimental purposes, and the student is expected to examine and find the best method of their treatment, mechanical as well as metallurgical, and to form estimates of cost of treatment.

In the department of philosophy a wide field is traversed and lectured upon. Several of the subjects to a European student would be highly interesting, especially the history of Oriental philosophy, and the ideas put forth in such books as "Rongo, Mishi, Yoshisauron, Schikiogi, Yuimakio." The text-books on psychology, sociology, and kindred subjects used include the works of Bain, Maudsley, Spencer, Mill, Hume, Lewes, and others.

During his course of studies the student is submitted to

periodic examinations, on the results of which he is either promoted, degraded, or dismissed, according to the number of "marks" he has been able to score, and if he has been so unfortunate as to fail in any examination he is not allowed to be re-examined under any circumstances. Finally, as a reward for having undergone his examinational torture with credit in marks, a degree is granted him according to the subject he has studied. With regard to this matter of degrees we are told that "in early times the system of granting degrees to students existed but had been abandoned for a long time. This re-establishment of the system of granting degrees is to be regarded as a remarkable event in the history of Japanese education."

Journal and Proceedings of the Royal Society of New South Wales, 1882. Edited by A. Liversidge, F.R.S. Sydney: Thomas Richards. 1883.

This volume of the *Proceedings* of the Royal Society of New South Wales, the publication of which has been unavoidably delayed, contains a series of articles, sixteen in all, some of which are of an interesting character and indicate that the spirit of scientific enquiry exists in the colony. Now that this Society has been incorporated—in 1881—it is to be expected or at least hoped that the status that has thus been acquired will react with beneficial effect on its members, of which there is a considerable number, and that we shall soon learn of substantial investigations bearing on the many intricate problems concerning our fundamental ideas of matter, inorganised and organised, not only carried out by some of the members of the Society, but also published in these Transactions; investigations which, without that special character that may make them essentially of local interest, utilise the local opportunities towards the elucidation of the great scientific questions of the day. The publication of such work in the future volumes of the Society will, we trust, at a not far distant date, cause these volumes to be as well known and referred to as those of kindred scientific bodies.

Although the quantity of matter that is here produced is less than might be expected when all things are considered, the activity of several of the members who have the Society's reputation at heart must be acknowledged, and it is to be hoped that their efforts may stimulate many of the others to scientific enquiry.

In the anniversary address the President, Mr. H. C. Russell, confines himself to astronomical and meteorological matters, discussing the probable value of the parallax based on the results that have been obtained by the various methods of observation, and gives an account of the efforts that were being made in the colony, when the address was delivered, for the observation of the transit of Venus in 1882.

A considerable portion of this address is devoted to an interesting *resumé* of all the known facts relating to the "artificial" production of rain by large conflagrations, discharges of artillery, and such like, a subject which for the inhabitants of a pastoral or agricultural country favoured with too much sunshine is of much concern, certainly merits a full discussion, especially when we read that "so many proposals are put forward, some even going so far as to propose that our Government should take to cannonading the sky, it was time someone took the matter up." The aqueous vapour arising from a large conflagration producing rain is conceivable, but to "tom-tom" the sky with guns or other means in order to bring down rain would seem to be the height of absurdity.

The contributions to chemistry in this volume consist of descriptions with analyses, by Prof. Liversidge, of the Deniliquin and Bingera meteorites, together with two preliminary notices on the chemical composition of certain rocks from New Britain and New Ireland. Mr. W. A. Dixon gives several analyses of the ashes of certain epiphytic orchids. Geological science is represented by a series of papers by the Rev. J. E. Tenison Woods; that on the "Hawkesbury Sandstone," with the discussion that took place on its reading, which is added, being especially valuable. To the student of ethnology and sociology there are two papers in this collection that will be of some interest, relating to the customs of a race of beings rapidly becoming extinct, and of whom in a few years there will be little more left us than there is of the dodo. The notes on the Aborigines of New Holland, by Mr. James Manning, are particularly interesting, as they relate to the state of these people and their religious beliefs according to the writer's experience made forty years ago, before the race had lost all their native habits and became demoralised "between the missionaries and the rum." The article on the Aborigines of New South Wales, by Mr. J. Fraser, describes many of the ceremonial institutions, and is of much ethnological interest.

American Gems and Precious Stones. By George F. Kunz. Washington: Government Printing Office. 1883.

This small pamphlet contains short but interesting notes on the minerals found in the United States that are used for ornamental purposes, being an extract from "The Mineral Resources of the United States." The information here brought together is of a statistical character valuable to the dealer in precious stones and the lapidary, no attempt being made to describe these minerals in an abstruse way, or the parageneses of the different species.

The probability is great that the mineral veins of the United States will at some not far distant date yield a good supply of precious stones, although statistics relating to the present production are not of a very encouraging nature. It is difficult, if not impossible, to obtain accurate facts regarding the quantity of minerals found annually fit to be termed precious stones, but the author of this pamphlet, from an extensive correspondence with experts and dealers, estimates that the sales in 1882 of all gems of home production amounted to between fifty and sixty thousand dollars, the value of the stones before cutting being probably about ten thousand dollars, whereas for the same year the value of the precious stones imported into the country was over eight million dollars.

Although the geological structure of many districts in the United States would warrant a systematic search being made for precious stones, as yet, however, only at two places, Paris Maine and Stony Point, North Carolina, is mining for such minerals carried on; in many other cases the gems that are reported to have been found are either met with accidentally or found in mining for the commoner minerals. The sapphires, garnets, and olivines from Montana and New Mexico are gathered from the surface with little or no mining, the moss-agates from Colorado are picked up from the beds of the streams, and the specimens of chlorastrolite and thomsonite from Lake Superior are found on the beaches. The geological characteristics of North Carolina, as well as the garnet districts of Arizona and New Mexico, would seem, according to practical geologists, to hold out favourable prospects for the prosecution of diamond mining, but as yet only a few finds of this valuable gem are reported, as from Idaho, Cherokee Flat, San Francisco, and at the Portis Mine, North Carolina. The largest diamond yet known to have been found in the United States was picked up by a labourer engaged in grading one of the streets in Manchester, Chesterfield County, which weighed 10 carats after cutting. This specimen was sold by the finder for 1800 dollars, although its value was about three times this sum.

The sapphires and rubies found at Vernon, New Jersey, are always more or less opaque, and although some specimens have been cut their want of transparency does not entitle them to the term of gems. Better finds are reported to have been made at the Corundum Mines, North Carolina, the stones here met with being of high class colour but small, a few weighing about 2 carats; the highest value of any single gem probably not exceeding 100 dollars. In the garnet districts of Montana, Santa

Fé, Southern Colorado, and Arizona, rubies and sapphires occur in the sand associated with peridote, pyrope, and almandine garnet; occasionally, too, this gem stone is found on ant-hills, which abound in the last named district. The gems are usually of a pale green, greenish blue, or light red tint, and are dichroic, perfect stones weighing from four to six carats being frequently found.

A few fine specimens of spinel are reported from San Luis Obispo, California, weighing about 2 carats each. Topazes, suitable for ornamental purposes, have been picked up in Arizona, New Mexico, and occasionally in Southern Colorado. More recently crystals have been found at Pike's Peak, Colorado, and at Stoneham, Maine. Many of the specimens are of a pale blue tint, and might be cut into gems; the supply, however, is very small, probably not more than 100 dollars yearly.

The beryl gems are found in many parts of the States, often in crystals of large dimensions, but specimens of a good colour are comparatively rare, the finest, of a rich blue tint, occurring at Royalston, Massachusetts. The supply of these gems is not great, the entire amount for the last ten years, the author states, would not exceed 2000 dollars. Crystals of phenakite have been found at Pike's Peak, Colorado, some of them of remarkable clearness and equal in size to the specimens from Siberia. Zircons, although found in some abundance in North Carolina, are for the most part too imperfect in colour and size to be of much value as gems. Hiddenite or "lithia emerald," a new and strictly American mineral, is found associated with beryl, rutile, and garnet; stones weighing up to 2¼ carats and of good colour have been discovered. This mineral, the demand for which at present exceeds the supply, forms with tourmaline the only precious stones that are actively mined for in the United States.

Large numbers of very fine perfect crystals of quartz are found embedded in the calcareous sandstone in Herkimer County at Lake George, and in New York State, and form an item of some commercial value in these districts, being sold to tourists as "Lake George Diamonds." In Arkansas, at Crystal Mountain, and the district round the Hot Springs, the trade in quartz crystals is also considerable; this mineral being collected by the farmers by the waggon load, "who often do blasting to secure the crystals, looking for them at such times as their crops need no attention. In the course of a year possibly 100 loads are sold, principally as mementos, to the visitors at these resorts."

Regarding the occurrence of turquois in New Mexico the author gives a short account of the localities where this mineral has been found, quoted from two observers who have been over the country. Although there is evidence to show that this mineral has been prized by the Indians, and that mining operations have been conducted for a long time, the mines being known to have been well developed in 1680, yet at present the output is very small; the material cut and sold as gems not being more than 1500 dollars per annum, the specimens being sold merely as oddities.

To this short pamphlet Mr. Kunz appends a list of gem stones known to occur in the United States, and of a few that are known only to have been found in the country.

CORRESPONDENCE.

IRON IN CHLOROPHYLL.

To the Editor of the Chemical News.

Sir,—Dr. A. B. Griffiths seems to have misread Dr. Schunck's paper on chlorophyll in the *Proceedings of the Royal Society*, and has tested for iron in the residue instead of in the solution obtained by boiling leaves in alcohol. He also does not appear to have seen Dr. Schunck's supplementary note in the same number of the *Proceedings*, in which he shows that chlorophyll is not a glucoside.

The possible existence of iron in chlorophyll seemed a matter of such importance that during this week I have had some of the ethereal solution prepared from spinach according to Dr. Schunck's directions, and which therefore contained the glucoside in addition to the chlorophyll. The solution was evaporated, and a quarter of a decigrm. of the residue placed on platinum foil, ignited, a small piece of nitre added to burn off the last traces of carbon and to oxidise the iron. The foil was then boiled in concentrated hydrochloric acid, the solution evaporated to dryness to expel the excess of iron, and the residue dissolved in water and tested with potassic ferrocyanide and potassic sulphocyanate. In both cases there was only the very slightest indication of iron. In another experiment, in which the acid was not evaporated off, no colour was produced by the ferrocyanide, although about half a decigramme of the chlorophyll residue was used.

It may be useful to state that the spinach was grown in the College garden, and that the soil in this neighbourhood contains an appreciable quantity of iron, the water from an old pump, now disused, coming up inky when a new leather bucket had been put to the piston.—I am, &c.,

Herbert McLeod.

Cooper's Hill, June 7, 1884.

EFFECTS OF SULPHUR AND CHLORINE ON PLANTS.

To the Editor of the Chemical News.

Sir,—A letter appeared in your columns recently (p. 229), signed by "F. J. Lloyd," in reference to the injurious effects which have been found to follow the use of sulphur and chlorine in manures (notably in superphosphate and in sulphate and muriate of potash). I think it well to say, for the benefit of those who may not be so familiar with the subject as to discern it for themselves, that there is nothing in that letter explanatory of the results nor worthy of being noticed in detail.—I am, &c.,

T. Jamieson,
Lecturer on Agriculture,
University of Aberdeen.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 17, April 28, 1884.

Absolute Standard of Light.—J. Violle.—The author takes as his absolute unit the radiation emitted by a square centimetre of platinum at its point of solidification, the intensity of which is about equal to 11 Carcel lamps.

Determination of the Ohm.—E. Mascart, F. de Nerville, and R. Benoit.—The authors conclude that the value of the ohm is represented by a column of mercury at 0° of 1 square millimetre in section and 1063·3 millimetres in length.

Apparent Resistance of the Voltaic Arc in Lighthouses.—F. Lucas.—With an intensity of 50 ampères, and a distance of 0·004 metre between the points of the Carré carbons,—which are the normal conditions for the production of the voltaic arc in lighthouses—the resistance of the arc is 0·58 ohm.

Telluric Currents.—E. C. Blavier.—The variations of terrestrial magnetism, whether regular or accidental, are

due to electric currents which circulate in the atmosphere at a greater or less distance from the ground, and the circuit of which is completed either directly when they encircle the entire globe or by the intervention of the earth, but at a depth sufficiently great to have no action upon the magnetic needle.

Application of the Laws of Induction to the Helio-electric Theory of the Perturbations of Terrestrial Magnetism.—M. Quet.—When the solar currents vary suddenly in intensity, the resulting force of induction must seize simultaneously all the parts of the electric fluid of the earth, and the magnetic perturbations which result must commence simultaneously on all points of the globe.

Direct Determination of the Order of the Cause of the Deficiency in Electro-dynamic Machines.—G. Cabanellas.—This paper does not admit of useful abstraction.

Congelation-point of Solutions of the Salts of the Diatomic Metals.—F. M. Raoult.—All the neutral salts resulting from the action of monobasic acids upon the oxides of the biatomic alkaline-earthy and earthy metals produce a molecular depression of the coagulation-point comprised between 41 and 48, with a mean of 45. All neutral salts resulting from the action of the bibasic acids upon the same oxides produce a molecular depression of congelation included between 18 and 22, with a mean of 20. Whenever in the molecule of a salt of a monobasic or bibasic acid, supposed to be dissolved in 100 grms. of water, 1 atom of diatomic alkaline-earthy or earthy metal is replaced by an equivalent quantity (*i.e.*, two atoms) of a mono-atomic metal, the depression of the congelation-point increases by a quantity which is almost constant. Double decompositions which may take place without the formation of a precipitate among neutral salts of the diatomic alkaline, alkaline-earthy, or earthy metals, with monobasic or bibasic acids produce in the congelation-point of the mixture either a very feeble change or none at all.

Formation of Amides by setting out from the Ammoniacal Salts of the Organic Acids.—N. Menschutkin.—The amides are formed at temperatures higher than 100° with a speed which increases with the temperature, and after a time a limit is reached. The general march of the reaction and its graphic representation at various temperatures are completely analogous to the formation of compound ethers in the reaction of the acids on the alcohols.

A Glucoside of Boldoa fragrans.—P. Chapoteaut.—This plant contains a feebly alkaline principle, *boldine*, and a glucoside $C_{39}H_{52}O_8$. If heated with dilute hydrochloric acid it is split up into glucose, methyl chloride, and a syrupy compound soluble in alcohol and benzol, but insoluble in water.

Researches on Hydraulicity: Influence of Heating and Carbonic Acid upon the Setting of Siliceous Cements.—E. Landrin.—This memoir does not admit of useful abstraction.

Existence of Manganese in Wines and in a Number of Vegetable or Animal Productions.—E. J. Maumené.—Manganese appears to exist in all wines, but its presence is purely accidental, and its quantity is too small to have any effect. In the cereals it is present to a much greater extent. The author thinks that it possibly plays a more important part in the life of animals than does iron.

Assimilability of Phosphoric Acid contained in the Rocks and in Arable Soils.—G. Lechartier.—The author shows that phosphoric acid as it exists in the chief rocks of Bretagne can be directly assimilated by plants. If phosphoric acid has been extracted from rocks, &c., by means of ammonium oxalate, it cannot be precipitated from the solution by means of molybdic mixture. The solution must first be evaporated down, the salt decomposed by heat, and the phosphoric acid separated from the ferruginous residue obtained.

Researches on Respiratory Combustion.—P. Schützenberger.—Not adapted for abstraction.

No. 18, May 5, 1884.

This number contains no memoirs, being taken up with the awards of the various prizes which the Academy has to confer.

Moniteur Scientifique, Quesneville.
Vol. xiv., April, 1884.

Patents and Certificates of Addition taken in France during the year 1884.—The nature of this article appears sufficiently from its title.

Patents concerning Colouring-Matters issued in Berlin during January and February, 1884.—A list of specifications not capable of useful abstraction.

Modern Processes for Dyeing: Recent Improvements in Fixing Colouring-Matters upon the Fibre.—Dr. Riemann.—The author defends the use of antimony—tartar emetic—in mordanting cottons to be dyed in aniline colours. He insists on the importance of abandoning the original method of dyeing silks and woollens in anilines without any mordant, and recommends, in case of woollens, the addition to the dye-beck of zinc sulphate, the goods being afterwards taken through soap-lye or through a solution of soda crystals. Shades got up in this manner bear not merely soaping, but in many cases even fulling. He points out that eosine and its kindred, unlike the original coal-tar colours, have a radicle which is not basic, but acid. The eosines, in spite of their beauty, have but a limited application, on account of their inability to resist the action of light. In like manner the azo-reds cannot be used as substitutes for cochineal in dyeing army-cloths. Lac-dye, though much employed thirty to forty years ago, is now known to the majority of dyers merely by name. (We can attest that sixteen years ago it was abundantly used in Yorkshire.) Safflower, Dr. Reimann further asserts, has been displaced by saffranine and by madder, which in turn have given place to artificial alizarin. (It may surely be questioned whether either natural or artificial alizarin can produce pinks and roses equal in purity and lustre to the safflower shades.)

The Colours employed in Calico-printing, and the Means used for their Fixation.—Robert Bourcart.—This memoir is an account of the methods commonly used in England, and is not susceptible of useful abstraction.

Contribution to the Chemistry of Mordants.—MM. Liecht and Suida.—From the *Journal of the Society of Chemical Industry*.

On Chemical Manures.—Dr. Cohn.—A summary of the known sources of ammonia, potash, and phosphoric acid, and of the means of rendering the latter available.

Industrial Society of Mulhouse.—Meeting of the Chemical Section, February 13th, 1884.—The President read a communication, by MM. Depierre and Clouet, on the action of the electric light, and of solar light upon colours printed on cotton. They conclude that the electric light bleaches colouring-matters: the coloured rays both of sunlight and of the electric light are efficacious, though in different degrees. The action of light, solar or electric, is recognised whether the colours are exposed to or protected from the air. The order of action of the rays increases in the following order:—Yellow, blue, green, orange, violet, red.

M. A. Haller, of Nancy, sent in a memoir on cyanomalonic acid and its derivatives.

M. Goppelsrœder sent in a memoir on the reduction of indigo by electrolytic hydrogen.

M. Nœlting described certain researches undertaken in concert with M. Binder, on the transformation of the diazo-amido derivatives into amido-azo compounds.

Review of Chemical Researches published Abroad.—A series of abstracts from the *Berichte der Deutsch. Chem. Gesell.*, and from *Liebig's Annalen*.

On Vaseline.—J. Otto.—An account of the preparation and pharmaceutical uses of this body. Its valuable properties have been much exaggerated. In contact with air and light it is decidedly capable of becoming rancid.

Liquid Carbonic Acid under a Regular Pressure.—A. Zimmermann.—From the *Journal of the Society of Chemical Industry*.

Archives Neerlandaises des Sciences Exactes et Naturelles.
Tome xviii., Part 5.

Hæmatoxylin as a Special Reagent for Cellulosic Membranes, neither Lignified nor Suberified.—E. Giltay.—The author prepares this reagent by taking 5 c.c. of a solution (kept in reserve) of 7 grms. hæmatoxylin in 50 c.c. of water, and adding these 5 c.c. to 100 c.c. of a solution of alum at $\frac{3}{4}$ per cent. It is well to prepare this mixture a couple of days before using it, and to filter a small quantity each time. For use the liquid is poured into a glass in a shallow stratum, not more than $\frac{1}{2}$ c.m. at most, the section of tissue is introduced into the liquid, and the glass is held above a small mirror, inclined so that the light may be thrown through the reagent. Cellulose, if present, is coloured blue, whilst lignified or suberified tissues are not acted on.

Cosmos les Mondes.
No. 14, April 5, 1884.

Gas from Farmyard Manure.—It is said that the gases given off during the fermentation of dung in a closed vessel consist so largely of hydrocarbons that they may be used for lighting purposes. M. Gayon is said to have exhibited this light at Bordeaux.

No. 15, April 12, 1884.

Glue for Rendering Paper Waterproof.—Labels may be fixed upon tin boxes, &c., exposed to damp by the following method. White of egg is diluted with one half part of water and applied with a brush to the surfaces to be united. A hot iron is then passed over the paper, so as to coagulate the albumen. By means of successive layers of paper and albumen, waterproof boxes, &c., may be formed.

Combination-Heats of the Compounds of Sodium.—Dr. T. Tommasi.—A table of the combination-heats of sodium salts, as calculated and determined experimentally.

The Radiguet Constant Battery.—This paper requires the four accompanying illustrations.

A New Source of Electricity.—J. A. Kendall.—From the *Proceedings of the Royal Society*.

No. 16, April 19, 1884.

M. Honigmann, of Aix-la-Chapelle, propels a locomotive without fire and without coal by means of caustic soda.

The *Journal d'Hygèine* ascribes great antiseptic and germicide power to free citric acid.

In the town of Utrecht, which is supplied with an exceedingly pure water, it has been found necessary to make use of tin service-pipes coated externally with lead.

Professor Landolt has recently exhibited to the Berlin Academy of Sciences a cylinder of solidified carbonic acid which he kept for more than an hour in that state. He had passed the current of liquefied carbonic acid from a compressor into a conical bag, in which it resembled melting snow. It was then pressed in a cylindrical mould by means of a rammer.

No. 17, April 26, 1884.

This issue contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Separation of Tartaric and Phosphoric Acids.—I have a mixture of acid phosphate of lime and tartarate of lime, with an excess of sulphuric acid, all in solution, and require to determine the sulphuric, phosphoric, and tartaric acids. Can any of your readers supply a good method for the quantitative separation of tartaric and phosphoric acids?—W. M. Allan.

MEETINGS FOR THE WEEK

Saturday, 14.—Physical, 3. "On the Velocity of Sound in Tubes," by D. J. Blaikley. "On a New Apparatus for Colour Combinations," by H. H. Hoffert.
Wednesday, 18th.—Meteorological, 7.
Thursday, 19th.—Royal, 4.30.
— Royal Society Club, 6.30. (Anniversary).
— Philosophical Club, 6.30.
— Chemical, 8. "On the Magnetic Rotation of Chemical Bodies in relation to their Composition and Constitution," by Dr. Perkin; "On the Effect of High Temperatures on Petroleum Hydrocarbons," by Drs. Armstrong and Miller; "On Nitrification" (Part III.)," by R. Warington.

THE JOURNAL OF SCIENCE,

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CONTENTS.

1. What is Religion? Hylo-Idealism? By S. Billing.
2. On Electricity and its Present Applications. By W. Fraser, A.M., M.R.C.S.
3. On the Clorophyll of Living Plant-Cells, and on the Assimilation of Carbon.
4. Technical Trials. By An Old Technologist.
5. The Health Exhibition.

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H. D. ELLIS, Secretary.

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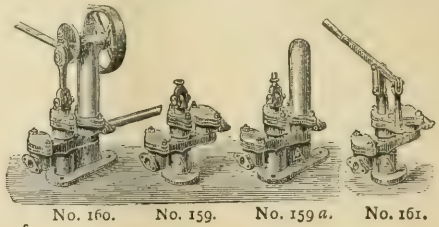

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THE CHEMICAL NEWS.

VOL. XLIX. No. 1282.

THE PHYSICAL AND CHEMICAL ANALYSIS OF FLOUR.*

By ALBERT R. LEEDS.

THE great attention paid during five years past in the United States to the subject of the adulteration of foods has already resulted in a voluminous literature. Unfortunately, much of this literature is crude and erroneous, and especially that referring to the topic of the present article. Originally appearing with specious pretences of scientific merit in certain medical journals, these misstatements have gained credence with many reputable medical practitioners. Finally, having permeated downward into the columns of the daily press and into the popular mind, they have become so firmly lodged as to make their eradication difficult.

Foremost in this direction was a paper published in Gaillard's *Medical Journal*, January, 1882, with the following alarming title:—"Highly important and extensively advertised cereal foods under the microscope. The genuine, the spurious, the worthless, and the fraudulent. Therapeutic as well as dietetic facts of great value to physicians and their patients. By Ephraim Cutter, A.M., M.D., Harvard, &c." The only means of research employed by the author of this paper was the microscope, which he styles an "unerring teacher," "an infallible detector of fraudulent claims in regard to cereal foods," &c. The results of microscopic examinations are termed analyses, and as such are expressed in *figures denoting the relative percentages of gluten and starch*. The principal feature of the article, and the one most calculated to awe and convince the popular mind, was the woodcuts with which it was profusely illustrated, and which purported to be impartial representations of what might be seen of these foods when looked at through an objective, magnifying 800 diameters. Some of these cuts or slides represent flour entirely made up of unruptured gluten cells, while specimens of other flour, quite as remarkable, but for a different reason, are represented as composed of starch cells and fibrous tissue only. The two flours which are more especially singled out, the one for unstinted praise, the other for condemnation, are the Franklin Mills Entire Wheat Flour, and the Gluten Flour of the New York Health Food Co. Besides the woodcuts which represent the former as composed almost entirely of gluten cells, the excellence of the former flour incites the microscopist to add that, "So long as the makers maintain such a proportion of gluten cells, they confer a blessing on mankind." On the other hand, the gluten flour is stigmatised as "a meal and not a flour. The circulars are travesties, and show an ignorance which, if it did not affect human life, would be ridiculous. In all this so-called gluten flour which the microscopist examined, he states that in repeated examinations only seventy gluten cells were found.

Chemical analyses show the falsity of these statements, as I will explain later on. But even without the aid of positive knowledge, founded on analytical data, these statements should have deceived no one accustomed to the use of the microscope, as is evident from the following considerations:—In the first place, in making a chemical analysis of flour, as much as 10 grms. should be used. The analysis of so large a quantity affords a guarantee that the figures obtained represent the average composition of a mechanical mixture of the constituents of a non-homogeneous product like flour. But the weight of flour exhibited on a microscopic slide does not exceed the 1-100,000th part of the quantity taken for chemical analysis, and could not fairly represent an average. Neither can one determine by counting upon one slide or upon a hundred slides, the relative number of starch cells and *unruptured* gluten cells, what is the percentage of starch and gluten. It could not be done even were the gluten cells unruptured. But in the process of grinding they are largely broken and their contents commingled with the starch. When so commingled, it is difficult even with the aid of chemical reagents to discriminate between the albumenoid and amyloid constituents of flour. To estimate their percentage amounts by counting is impossible.

So different in appearance are the various parts of one slide, and so different are various slides prepared from one and the same flour, that the use of pictures of such slides to substantiate statements as to differences in composition in the flours examined, is misleading. Lest any microscopist should regard this protest as unnecessary, since it is but insisting upon a matter with which he is already familiar, let him call to mind how successfully the public is deceived by the claim that microscopic research necessarily implies research of great scientific exactitude. In the present instance certainly, authorities in medical science were led astray. Had they but reflected for a moment that Dr. Cutter's assertion, that many of the cereal foods examined contained no gluten whatsoever, was in itself a sufficient proof of the falsity of his statements, insomuch that there is no flour but what necessarily contains some gluten, they would not have indorsed his publications without independent examinations. But in an address delivered before the New York Medical Society, February 8th, 1882, its President, Dr. A. Jacobi, says of these microscopic examinations of Dr. Cutter: "I shall refer to his statements, desiring to give them the greatest possible publicity. I wish the brief article of his would be distributed in a hundred thousand copies, reprinted in every secular paper, read from every platform and pulpit of the land. For it is time that fraud should be stopped, and a nefarious trade suppressed."

Then follows a *résumé* of Dr. Cutter's labours, in which without any assurance on the part of the presiding officer of a distinguished medical society, that he has submitted statements involving the reputation and business fortunes of more than two-score of the manufacturers of cereal foods in the United States to any independent critical research, he bestows indiscriminate and exaggerated commendation upon them all.

In a paper published in the *Transactions of the College of Physicians of Philadelphia*, 3rd series, vi., 377, I have given the results of the examinations of many of the foods referred to, the examinations being conducted with the aid of the microscope and mechanical manipulations, but controlled by chemical analysis. Without quoting in detail, I shall insert in this place only the table of analyses as showing how incorrect was the statement made by Dr. Cutter and approved by Dr. Jacobi, of the absence of gluten in Blair's Wheat Food, "Imperial Granum, Ridge's Food, Savory and Moore's Food, Farwell and Rhine's Gluten Flour, Hubbell's Prepared Wheat," and other cereal preparations.

The microscopic drawings alluded to were made, it is stated, by Dr. A. T. Cuzner. Recently, in what purported to be a summary of certain information contained in a book entitled "What we Eat and What we Drink," this gentleman has published, under the title of "Food Analyses—Flour," a paper in the *Scientific American*, Supplement, No. 414, in which statements are made similar to those advanced by Dr. Cutter, but nominally supported by proofs of quite different character. The fact that the microscope gives incorrect notions of the relative amounts of gluten and starch is admitted, and the attempt to make a quantitative analysis of flour by the use of this instrument

* Advance sheets communicated by the author. Reprinted from the *Journal of the American Chemical Society*, vol. vi., No. 3.

Analyses of Health and Infant Foods.

Food Analysed.	Water.	Fat.	Grape Sugar.	Cane Sugar.	Starch.	Soluble Carbohydrts.	Albuminds.	Gum, Cellulose, &c.	Insol. Residue.	Total.	Reaction.
Baby Sup, No. 1	5·54	1·28	2·20	11·70	61·99	14·35	9·75	7·09	—	100·00	Neutral
Baby Sup, No. 2	11·48	0·62	2·44	2·48	51·95	22·79	7·92	5·24	—	100·00	Slightly alkaline
Gerber & Co.'s Milk Food .	6·78	2·21	6·06	30·50	38·48	44·76	9·56	—	—	101·79	Slightly acid
Ridge's Food for Infants..	9·23	0·63	2·40	2·20	77·96	5·19	9·24	—	—	102·25	Neutral
Victor Baby Food	7·49	1·62	0·62	19·92	63·45	20·54	8·87	—	—	101·97	Slightly acid
Anglo-Swiss Milk Food ..	6·54	2·72	23·29	21·40	34·55	46·43	10·26	—	—	100·50	Slightly acid
Horlick's Food for Infants.	3·39	0·08	34·99	12·45	none	87·20	6·71	—	2·62	100·00	Slightly acid
K. and M.'s Infants' Food.	27·95	—	36·75	7·58	none	71·50	none	—	0·55	100·00	Neutral
Nestle's Milk Food	4·72	1·91	6·02	32·93	40·16	44·88	8·23	—	0·08	100·00	Slightly alkaline
Hawley's Liebig's Food ..	6 60	0·61	40·57	3·44	10·97	76·54	5·38	—	—	100·10	Slightly acid
Hazard's Graham Farina..	9·12	0·81	2·19	2·49	69·68	6·35	8·48	5·56	—	100·00	Neutral
Cereal Milk..	9·33	1·01	4·60	15·40	58·42	20·00	11·08	—	—	100·16	Slightly acid
Mellin's Food	5·00	0·15	44·69	3·51	none	85·44	5·95	—	3·46	100·00	Slightly alkaline
Blair's Prepared Wheat Food	9·85	1·56	1·75	1·71	64·80	13·69	7·16	2·94	—	100·00	Neutral
Savory & Moore's Infts. Food	8·34	0·40	20·41	9·08	36·36	44·83	9·63	0·44	—	100·00	Neutral
Hubbell's Preprd. Wheat Fd.	7·78	0·41	7·56	4·87	67·60	14·29	10·13	undet.	—	100·21	Neutral
American-Swiss Milk Prdct. Co.	5·68	6·81	5·78	36·43	30·85	45·35	10·54	0·77	—	100·00	Acid
Wheat Flour for Hubbel's Wheat Food..	9·02	1·01	2·34	2·46	76·07	5·66	6·40	—	—	—	Neutral
Imperial Granum..	5·49	1·01	trace	trace	78·93	3·56	10·51	0·50	—	100·00	Neutral
Robinson's Patent Barley ..	10·10	0·97	3·08	0·90	77·76	4·11	5·13	1·93	—	100·00	Neutral
Farwell and Rhine's Gluten Flour	12·67	0·84	2·23	1·42	68·36	7·23	10·39	0·51	—	100·00	Neutral

is abandoned. At the same time the pictures of flour as seen under the microscope are quite different from flour as it actually appears when thus examined.

In the accompanying reproduction of the drawing made by Dr. Cuzner, No. I. fig., and purporting to be a micrograph of the Pillsbury best flour, the large circles with rays or crosses at their centres, and marked A, are stated to be pictures of giant starch cells; B to stand for smaller starch cells, and C for granular gluten. Whether C is a mere dot, or a very small circle without a dot in its centre, is not clear from the drawing. But that the smaller starch cells are circles with dots in their centres appears to have been certainly intended.

This drawing presumably represents the appearance in ordinary light, but in that light starch granules do not exhibit crosses, nor in any light crosses of the character depicted in the drawing. Moreover, gluten cannot be distinguished from starch in the manner stated.

The next photo-engraving, No. II., is a reproduction which (to quote the language of the original article) "represents the appearance of the Franklin Mills flour, and equally well represents the Health Food Company's flour, with the exception that in this flour is seen a *much larger proportion* of the bran coat with gluten cells attached, as well as unattached, together with some *hairs of wheat*, than is found in the Franklin Mills flour. In the figure, A, are seen giant starch cells; B, portion of bran coat; C, portion of bran coat with gluten cells unruptured."

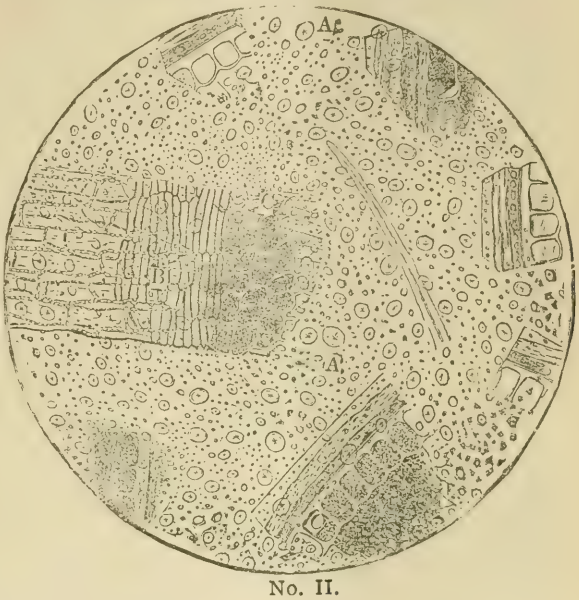
The microscopist will be struck by the remarkable fact that this cut, which is entitled "Health food gluten flour as seen under the microscope," represents a number of thin sections of the wheat-berry. Most of these sections are transverse, and represent very beautifully the epicarp, endocarp, testa, and secundine of the berry, precisely as they appear when viewed in their natural positions to one another. The largest section is a diagram illustrating the relative position of the three outer coats of the berry as viewed from without. It is a matter of nicety to prepare such excellent sections of the berry, when it is sliced with a knife, and in the crushed fragments of the berry that remain after it has been ground into flour I had never seen anything of the character above figured. But, thinking other observers might have been more fortunate, I looked through the literature of the subject, and found precisely the same diagrams as those figured by Dr. Cuzner. In the latter case they appear in company with giant starch cells (granules?), whose magnitude is comparable with he unruptured gluten cells. In the former they appear as illustrations of thin sections of the berry, Fig. 3 in the above cut No. III., showing "the relative position of the several layers of the investing coats of the berry, as seen from without; Fig. 4, as viewed in a section transverse to the greater length of the berry; Fig. 5, as presented in longitudinal section." In the latter case, as reproduced by Dr. Cuzner, they are portions of what he saw when Health Food gluten flour was examined under the microscope; in the former they form the cut which can be found on page 4, "Report on Vienna Bread," printed in 1875 at the Government Printing-Office in Washington, this Report having been written by E. N. Horsford, U. S. Commissioner to the Vienna International Exhibition, 1873. I have had this last cut, No. III., reproduced by photo-engraving to compare with Dr. Cuzner's No. II.

It is needless further to insist upon the worthlessness of mere microscopic inspection in determining the relative composition of flour. But after the erroneous nature of the results arrived at by Dr. Cutter by means of microscopic inspection only had been pointed out, one of his critics, Prof. J. G. Richardson, in an article entitled "A Serious Microscopic Blunder" (*Phila. Med. News*, June, 1882), called attention to the fact that he or any other physician, without the employment of the more exact methods of chemical analysis, could obtain sufficiently approximate results by simple manipulation of flour to prevent them from being led astray in the matter. He says:—"Dr. Cutter asserts that the opaque, oval, or rounded cells (constituting the fourth coat of the wheat grain, according to Prof. Parkes) afford most of the gluten, and hence on their presence the chief strength of the food depends." He therefore declares that a large number (fourteen) of the food-stuffs he examined, and found under his microscope to display none of these so-called "gluten-cells," "contain no gluten" (page 9), and broadly intimates that they are consequently frauds upon the public. But the fact is, these so-called "gluten-cells" (denominated by Payen *oleiferes*) probably include in their substance starch, phosphates, fatty matters, and colouring materials, containing only parts, perhaps but a small part, less than one-seventh, of the gluten which exists in wheat. Thus Peligot, as a mean of fourteen analyses, gives the percentage of gluten in flour (whence "gluten-cells" are removed) at 12·8, while in bran (containing nearly all the "gluten-cells") it is only 10·84, and other observers confirm his statements. If my friend Dr. Cutter, or any of his disciples, would like to satisfy himself that he has made a lamentable mistake in this matter, let him take

say 10 grms. of one of the fine flours he asserts "contain no gluten," mix it with water into a dough, let it stand for half an hour, and then stir it in a porcelain capsule, with successive portions of water, until the starch is washed away, and the adhesive fibrillated gluten is left nearly pure, in the proportion, after drying, of from 7 to 12 per cent. (*Vide* Parkes's "Practical Hygiene," fifth edition, 1878, p. 224). The small starch corpuscles and granules, left by this process entangled among the threads of gluten, can be beautifully differentiated by adding a drop of iodine solution, which affords the usual deep blue reaction with the starch, but dyes the gluten filaments of a yellowish brown tint.

The chemist will recognise, in the above extract from Parkes's "Hygiene," the result of the investigations of v. Bibra, Millon, Rivot, Ritthausen, and others upon the gluten contained in cereals. The method elaborated by these chemists appears to have been adopted after the above suggestions. by Dr. Cuzner, but unfortunately with a modification which robs it at the same time of its simplicity and its value. For instead of manipulating the gluten-dough in a very small flow of water directly between the fingers (which is best), Dr. Cuzner proposes to tie it up in a muslin bag, and manipulate this in a jar of water until all the starch is washed out.

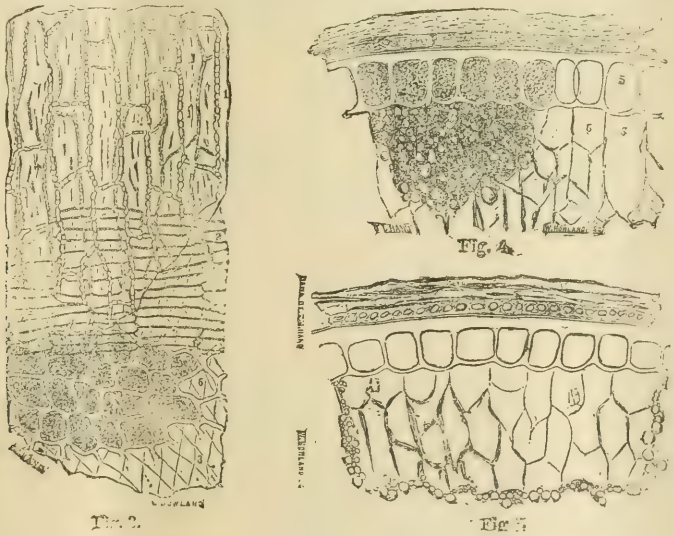
No. I.



No. II.

His language is—"Having an occasion to make an analysis of certain flours as to the relative amount of starch and gluten they each contained, I thought that the process adopted, being simple, and one easily carried out by persons of ordinary intelligence, it would interest your readers and give them the means of ascertaining for themselves the food value of any flour they might at any time be using as food in their families."

Then follows more in detail the process, which is as



No. III.

follows :—" A certain portion (2000 grs.) of each of these flours was mixed with water, separately from the rest, and inclosed in a piece of muslin, as we inclose a pudding. This inclosed dough was then kneaded in a certain amount of water in order to separate the starch from the rest of the flour. During this kneading process water readily passed through the cloth to the dough, and back again to the remainder of the water, carrying with it on its return the starch cells, albumen, and sugar. By continuing this kneading process the starch, sugar, albumen, and gum were finally separated from the gluten, which remained a soft, tenacious, elastic substance, insoluble in water, inside the cloth. The gluten was then removed from the inside of the cloth, moulded, dried, and weighed. The water containing the starch, gum, albumen, and sugar was placed in a vessel and allowed to stand for some hours, in order that time might be allowed for the starch cells to settle to the bottom.

" At the end of this time the water was poured off, and the starch moulded into a cake, dried, and weighed. In the examination of the Franklin Mills and Health Food Company's flour an additional process was required. During the kneading process, described above, the fine bran with adherent gluten cells was forced through the cloth and became mixed with the starch cells in the water. This water had to be filtered through very fine lawn muslin. The starch cells readily passed through this cloth, but the bran was detained on the muslin, and afterward collected, dried, and weighed. As the purpose of this analysis was not to ascertain the amount of albumen, gum, and sugar contained in the flours, but rather the amount of gluten and starch, the examination was continued no further. But if the reader should desire to ascertain how much albumen, gum, and sugar a certain amount of flour contains, the following process may be adopted : —Take the water poured off from the settled starch, and boil it. This will coagulate the contained albumen, which can be collected on a filter, dried, and weighed. The water that passes through the filter can afterwards be evaporated over boiling water, and the gum and sugar collected, dried, and weighed."

An entirely original and quite surprising use of pictorial illustration in connection with analysis is now given. Three rectangular blocks are depicted with sharp angles and perfectly plane sides as representing the dried gluten obtained from the three flours. They are all equally symmetrical, and distinguishable only by the fact that the Franklin Mills gluten cake is large, the Health Food Company's gluten small, and the Pillsbury gluten cake of intermediate size. The striking angularity and symmetry of these gluten blocks, which appear as if cut out of steel, is puzzling. Crude gluten, as I have encountered it, is an extremely tough substance, of a leather-like consistency, which, on drying, is puffed out by the imprisoned moisture in globular and more or less fantastic shapes.

Three equally symmetrical blocks, also in all respects similar, except in size, represent the starch. They have a monumental character, and more closely represent gravestones than anything in the nature of starch. Difficult as the task would be of moulding crude gluten into rectangular blocks, yet it would be easy of execution compared with that of compacting starch granules into similar masses,—an achievement thus far to me quite inexplicable. Two more solid blocks represent bran ; that from the Franklin Mills flour small, that from the Health Food Co. large. How bran which has been separated from both starch and gluten can be built up, compacted, dried, and weighed in coherent rectangular blocks is not explained.

The author then gives his results, which I have reduced to per cents, and supplemented with the percentages unaccounted for.

	Bran.	Gluten.	Starch.	Unaccounted for.
	Per ct.	Per ct.	Per ct.	Per ct.
Pillsbury best flour ..	—	13·25	80	6·75
Franklin Mills flour ..	2·5	15·75	50	31·75
Health Food Co. flour	7·5	7·00	45	41·5

The absurdity of styling that an analysis in which 30 to 40 per cent of the constituents of the flour are to be put down as albumen, gum, sugar, moisture, salts, &c., is manifest.

The process was then tried on some " Pillsbury best " flour and some Health Food Co.'s whole wheat flour : 150 grms. of each flour were taken, made into a dough, and inclosed in pieces of muslin cloth. These pieces of muslin cloth were previously washed, dried, and weighed. They were then kneaded in water until the washings were no longer milky, an operation requiring many hours, when the wash-waters—amounting in one case to 8, in the other to 10 litres—were collected and allowed to stand. At the end of a week the precipitation of starch was still incomplete, the supernatant liquid appearing milky. The liquid was then syphoned off, great care being requisite to prevent disturbance in the easily moved starch granules at the bottom. How to get rid of the last portions of water without losing some of the starch, and, in case this were successfully accomplished, how the starch could be detached from the vessels and moulded into cakes without loss,—these difficulties I saw no way of overcoming. Instead the starch was filtered off upon tared filters, and after drying at 110° in the ordinary manner was weighed.

The gluten was detached, as far as was practicable, from the muslin cloth, and, after drying the latter, the weight of the gluten which could not be detached was added to the weight of the main portion after drying at 110°. Great care must be exercised to obtain constant weights on drying, owing to the slowness with which the gluten gives up its last portions of moisture. If so many hours and such large amounts of water were requisite to wash the starch through ordinary muslin, the further separation of all this starch from bran by passing it a second time in a state of suspension in water through very fine lawn muslin, appeared impracticable.

The total soluble matter in the filtrates from the starch was determined, and also the crude gluten in the same. This was necessary, inasmuch as some of the gluten remained behind, and some passed through the muslin. Microscopic examination showed that the so-called starch contained cellular tissue and gluten, the so-called gluten contained cellulose and starch. Weighings performed on impure products of this kind of course have no real value

Physical Analyses by Washing in Bags.

	Pillsbury Best.	Health Food Flour
Starch	69·25 per cent.	52·92 per cent.
Gluten remaining in bag	3·40 ,,	21·41 ,,
Gluten in wash-waters	8 56 ,,	5·94 ,,
Soluble matters in wash-water..	4·94 ,,	4·96 ,,
Water in flour	11·10 ,,	11·32 ,,
Total found	97·25 ,,	96 55 ,,
Unaccounted for ..	2·75 ,,	3·45 ,,

Chemical Analysis of same Specimens of Flour.

	Pillsbury Best.	Health Food Flour.
Starch	67·86 per cent.	65·19 per cent.
Soluble albumen.. ..	2·84 ,,	2·30 ,,
Insoluble albumen ..	8·62 ,,	11·21 ,,
Total albumen	11·45 ,,	13·51 ,,
Sugar	2·83 ,,	2·67 ,,
Gum	5·02 ,,	3·84 ,,
Fat	1·31 ,,	1·63 ,,
Cellulose	0·81 ,,	2·35 ,,
Saline, &c.	0·42 ,,	1·38 ,,
Phosphoric acid	0·17 ,,	0·39 ,,
Water	11·10 ,,	11·32 ,,
Total..	100·81	101·89

The result of the latter analysis coming out differently from what I anticipated, former analyses having shown that the Health Food Flour contained much the largest

amount of albumenoids of any of the many samples of flour analysed, determinations were made of two more samples of the same flour. They agree better with the former figures, although still falling short in percentage of albumenoids of the results obtained on other samples.

	Lab. No. 1129.	Lab. No. 1130.
Starch	58·67	58·35
Gum	2·53	undet.
Sugar	5·39	,,
Soluble albumenoids ..	2·35	,,
Insoluble ,, ..	12·16	,,
Total ,, ..	14·51	13·74
Ash	1·30	1·58
Phosphoric acid	0·37	0·35
Cellulose	4·06	2·47

(To be continued.)

NOTE ON THE MOLECULAR VOLUMES OF SOME DOUBLE CHLORIDES.

By R. ROMANIS.

In a thesis communicated to the University of Edinburgh in 1876, I pointed out certain analogies between the molecular volumes of some hydrated double chlorides, and those of the hydrated magnesian sulphates investigated by Messrs. Playfair and Joule. They found, in the case of the double sulphates with 6 molecules of water, that the volume of the SO_3 of the magnesian sulphate disappears. Thus—

$(NH_4)_2SO_4$	78·4
RO	12·25
$6H_2O$	117·6
	208·25

Here the volume of the hydrated sulphate,—

$$(NH_4)_2SO_4.RSO_4.6aq,$$

is made up of the volume of the $(NH_4)_2SO_4$ + the volume of the oxide RO + the water as ice.

If we compare the volumes of the chlorides—

$$RPtCl_6+6H_2O,$$

we find that, like those of the double sulphates, they range from 200 to 215, and the volume may be considered to be made up thus :—

Average volume of the chlorides RCl_2	48·6
Vol. of $PtCl_2$	45·0
Vol. of $6H_2O$ as ice	117·6
	211·2

The anhydrous chlorides, $K_2PtCl_6(NH_4)_2PtCl_6$, &c., show some interesting relations. We find in all cases a great contraction. In the case of the ammonium salt, we have the atomic volume 148; the volume of $PtCl_4$ is 114·7; that of $2(NH_4Cl)$ is 71·32; hence a contraction of 38 takes place, equal to twice the volume of Cl in the chlorides of NH_4 and K, as estimated by Kopp. A similar contraction takes place in the case of the platinic chlorides of zinc, cobalt, nickel, &c. In the case of potassium platinic chloride the contraction is much greater, 54·5.

I have lately continued these experiments, and made a few determinations of the specific gravity of other classes of double chlorides. K_2SnCl_6 has the sp. gr. 2·948, and molecular volume 138·6; $(NH_4)_2SnCl_6$ has sp. gr. 2·511, molecular volume 146·1. The contraction in the case of the potassium salt is 52·5; of the ammonium salt 39·8, corresponding very closely with the platinochlorides.

When $PtCl_2.ZnCl_2$ and $SnCl_2$ combine with other chlorides expansion takes place. Thus—

$(NH_4)_2PtCl_4$, sp. gr. 2·84; mol. vol. = 132; the sum of the volumes of $PtCl_2$ and NH_4Cl is 116·8.

$(NH_4)_2ZnCl_4$, sp. gr. 1·77; mol. vol. = 137; sum of $ZnCl_2$ and $2NH_4Cl$ = 120.

The molecular volume of K_2SnCl_4 is 136·6.

The double salts derived from tri- and penta-chloride remain to be examined. The specific gravity of none of them is recorded. I have found the specific gravity of the salt $K_3SbCl_62H_2O$ to be 2·42, the molecular volume is 200·8, the contraction 52·6, nearly the same as that of the platinum and tin salts, but, as it is a hydrated salt, it cannot be strictly compared with them; and the molecular volume given by Kopp for $SbCl_3$ was taken at the boiling-point. The number at the ordinary temperature is probably between 80 and 90.

It would be premature to theorise until every class of double chlorides, bromides, iodides, and fluorides has been examined.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

GALLIUM.

Gallium has been so recently discovered, and obtained in such small quantities, that its atomic weight has not as yet been determined with much precision. The following data were fixed by the discoverer, Lecoq de Boisbaudran :†—

3·1044 grms. gallium ammonium alum, upon ignition, left 0·5885 grm. Ga_2O_3.

Hence Ga = 68·071. If O = 16, Ga = 68·233.

0·4481 grm. gallium, converted into nitrate and ignited, gave 0·6024 grm. Ga_2O_3.

Hence Ga = 69·538. If O = 16, Ga = 69·693.

These values, assigned equal weight, give these means :—

If O = 15·9633, Ga = 68·854. If O = 16, Ga = 68·963.

In brief, for all practical purposes, 69 may be assumed as the atomic weight of gallium.

INDIUM.

Reich and Richter, the discoverers of indium, were also the first to determine its atomic weight.‡ They dissolved weighed quantities of the metal in nitric acid, precipitated the solution with ammonia, ignited the precipitate, and ascertained its weight. Two experiments were made, as follows :—

0·5135 grm. indium gave 0·6243 grm. In_2O_3.
0·699 ,, 0·8515 ,,

Hence, in mean, In = 110·61, if O = 16; a value known now to be too low.

An unweighed quantity of fresh, moist indium sulphide was also dissolved in nitric acid, yielding, on precipitation,

0·2105 grm. In_2O_3 and 0·542 grm $BaSO_4$.

Hence, with $BaSO_4$ = 233, In = 111·544; also too low.

Soon after the publication of Reich and Richter's paper the subject was taken up by Winkler.‖ He dissolved indium in nitric acid, evaporated to dryness, ignited the residue, and weighed the oxide thus obtained.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Journ. Chem. Soc.*, 1878, p. 646.
‡ *Journ. f. Prakt. Chem.*, 92, 484.
‖ *Ibid.*, 94, 8.

0·5574 grm. In gave 0·6817 grm. In_2O_3.
0·6661 „ 0·8144 „
0·5011 „ 0·6126 „

Hence, in mean, if O = 16, In = 107·76; a result even lower than the values already cited.

In a later paper by Winkler* better results were obtained. Two methods were employed. First, metallic indium was placed in a solution of pure, neutral, sodio-auric chloride, and the amount of gold precipitated was weighed. I give the weighings and, in a third column, the amount of indium proportional to 100 parts of gold :—

In.	Au.	Ratio.
0·4471 grm.	0·8205 grm.	57·782
0·8445 „	1·4596 „	57·858

Mean 57·820 ± 0·026

Hence, if Au = 196·155 ± 0·095, In = 113·417 ± 0·074.

Winkler also repeated his earlier process, converting indium into oxide by solution in nitric acid and ignition of the residue. An additional experiment, the third as given below, was made after the method of Reich and Richter. The third column gives the percentage of In in In_2O_3 :—

1·124 grms. In gave	1·3616 grms. In_2O_3.	Per cent,	82·550
1·015 „	1·2291 „	„	82·581
0·6376 „	0·7725 „	„	82·537

These figures were confirmed by a single experiment of Bunsen's,† published simultaneously with the specific heat determinations which showed that the oxide of indium was In_2O_3, and not InO as had been previously supposed :—

1·0592 grms. In gave 1·2825 In_2O_3. Per cent In, 82·589

For convenience we may add this figure in with Winkler's series, which gives us a mean percentage of In in In_2O_3 of 82·564 ± 0·0082. Hence, if O = 15·9633, ± 0·0035, In = 113·385 ± 0·060.

Combining results, we have the following general mean :—

From gold series	In = 113·417 ±	0·074
„ oxide „	„ 113·385	0·060
General mean	„ 113·398	0·047

Or, if O = 16, In = 113·659.

NOTE ON PATCHING PLATINUM CRUCIBLES.‡

By H. J. SEAMAN, Catasauqua, Pa.

THE author gives his method of avoiding the losses incident to keeping platinum work in repair in laboratories where much fusion work is done. He rubs the crucible and the patch, which should be of stout foil, bright with silica, or rotten-stone, welds a light platinum wire to the corner of the patch, and treats the whole for several hours with hot concentrated hydrochloric acid, washing it then with distilled water, and drying. The head of an ordinary iron rivet is rounded off by hammering, and, after being sunk in a block of hard wood, is used as an anvil. The anvil is then heated to the highest point with a gas blow-pipe, fixed in a horizontal position, and when hot, the crucible is dropped on it. The patch is held over the point of operation by means of the thin platinum wire, and a few taps of a light hammer serve to fix it to the crucible. The wire is then nipped off, and the patch firmly united to the crucible by continued tapping, the metal being kept at as nearly a white heat as possible. Mr. Seaman has now three such patched crucibles, one of which has served for at least two hundred fusions, and is still in good order.—*Engineering and Mining Journal.*

§ *Journ. f. Prakt. Chem.*, 102, 282.
† *Poggend. Annal.*, 141, 28.
‡ Read at the Chicago Meeting of the American Institute of Mining Engineers.

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

June 14th, 1884.

Prof. F. GUTHRIE, President, in the Chair.

NEW Member :—Mr. Stanley Butler.

Mr. HOFFERT read a paper on a new apparatus for colour synthesis, which he exhibited. The colours are obtained by sending through prisms the light from a series of platinum wires made incandescent by Grove or other cells. Three different rays can be compared or superposed at a time by the instrument shown. The rays are received into the eye through an adjustable eye-piece; and various ingenious devices are adopted in the construction of the apparatus. The intensities of the lights are regulated by rheostats in the circuits of the platinum electro-pyres.

Lord RAYLEIGH, Mr. STANLEY, and Prof. PERRY commented on the apparatus, and Dr. Guthrie thought that it would be useful in studying colour-blindness.

Mr. BLAIKLEY read a paper on the velocity of sound in small tubes—a continuation of experiments formerly brought before the Society by the author. Mr. Blaikley showed experimentally how his measurements were made. He found that pipes in which the upper proper tones were in harmonic order, or, better still, those in which they were far removed from the harmonic order and therefore dissonant, were best for the purpose. He had obtained velocities from fine tubes varying from 11·4 to 88·2 millimetres in diameter, the former giving 324·38, the latter 330·13 metres per second as the velocity of sound. In free air Mr. Blaikley thought the velocity would come out 331 metres per second. The differences of velocity for the different pipes were very regular.

Lord RAYLEIGH, Dr. STONE, and Dr. GUTHRIE made some observations on the paper, Dr. Stone remarking that the diameter of a pipe modified the pitch of the same rate; a fact noticed in musical instruments. In experiments on water waves, Dr. Guthrie had found that in rectangular troughs the rate of oscillation was less than in circular ones.

Mr. HOWARD read a paper by himself and Mr. HAYWARD on the "*Thermal Relationship between Water and Certain Salts, such as Sulpho-ethylate, &c.*" Curves of results were given and interpreted.

On Furfurol.—Antony Guyard.—Furfurol is formed whenever a mixture of equal volumes of mono-hydrated sulphuric acid and water, whilst still hot, is thrown upon a matter consisting essentially of a carbohydrate, such as starch, glucose, sugar, saw-dust, filter-paper, &c. The vapours given off are more or less charged with furfurol. The presence of this body can be shown by effecting the reaction in a cylindrical glass, covered with a piece of filter-paper, steeped in aniline acetate. Furfurolic rosaniline is at once developed, the most magnificent but the most fugitive of the aniline reds which it has hitherto been impossible to fix. Furfurol exists in considerable quantity in pyroligneous acid, to which it imparts a bad taste. The author has succeeded in withdrawing the furfurol by shaking up the pyroligneous acid with 20 to 25 c.c. benzol per litre. On standing there are formed two strata,—a layer of benzol from which the furfurol may be separated by distillation, and a watery layer, from which a good vinegar may be obtained by simple distillation.—*Bull. Soc. Chim. de Paris*, No. 6, 1884.

NOTICES OF BOOKS.

A Short Text-Book of Inorganic Chemistry. By Dr. Hermann Kolbe, Professor of Chemistry in the University of Leipzig. Translated and Edited by T. S. Humpidge, Ph.D., B.Sc., Professor of Chemistry and Physics in the University College of Wales, Aberystwyth. London: Longmans, Green, and Co.

We are by no means sorry that this work has made its appearance in an English version. Prof. Kolbe is a chemist, not a meta-chemist. He insists on laying a solid foundation of facts for every law and theory, and he discusses the flights of fancy in which some of his contemporaries indulge in a sarcastic spirit. In scientific treatises he insists upon clear, definite ideas expressed in precise, unequivocal language. Hence he is far from popular among the weavers of gossamer hypotheses who do not like to be questioned concerning ths evidence of their assumptions and the exact meaning of their utterances. We need scarcely say that such a writer is needed in the present age.

The author's notion of what a lecturer on chemistry, and, consequently, a writer of an elementary text-book, ought to aim at is "to give his hearers an idea of chemical processes and the most important chemical theories without burdening their memories with a large number of mere facts, and thus to prepare them to acquire an accurate knowledge of chemistry by their own practical work." This is exactly our own opinion.

The author's classification of the elements is different from the traditional arrangement. Tellurium follows upon sulphur and selenium; arsenic and antimony succeed to nitrogen and phosphorus; whilst titanium, molybdenum, tungsten, vanadium, niobium, and tantalum, excluded from the class of metals, are appended to carbon. On the other hand, tin, which Professor Roscoe places among the non-metallic elements, ranks here between bismuth and copper. All the facts prove how obsolete is the division of the simple bodies into metals and non-metals, or as they are grotesquely termed on the Continent, metalloids.

The rarer metals are not omitted, but their full study is left to be conducted in the laboratory.

Returning to Professor Kolbe's preface, we find him urging that the chemist cannot learn by reading and hearing, but must see. "A person who, *e.g.*, has not *seen* the phenomena produced by the union of oxygen and hydrogen can have no clear conception of them, nor of the chemical change which accompanies them." He adds:—"Nothing is more foolish than the opinion, which I have often heard from young medical students, that chemistry can be studied from books alone." Singularly enough we came the other day upon a passage in a medical contemporary which shows how many medical students are content with a mere book-knowledge. "One ingenious gentleman, who had somehow learned how to fold a filter-paper, when requested to place it in the funnel, tried to balance it on the orifice of its spout; another could not form the slightest idea what a funnel might be used for. It is far from uncommon to find a funnel in either its simple or self-registering form above comprehension, &c."

Turning from the author to the editor we find that his part has been well performed. He remarks in his preface that "in adapting the book for English students certain alterations and additions were necessary, and to these the author has given his full consent." This sentence may give room for puzzling reflections. Why should a scientific text-book, which is found satisfactory in Germany, require alteration to adapt it for use on our side of the North Sea? It will be difficult to give a really sound answer to this query.

An appendix has been added by Mr. Humpidge containing some useful matter, such as an abstract of the methods followed in determining molecular weights, an account of Prout's law and of the periodic law. Concerning the latter generalisation he remarks that it is "a valuable but still imperfect representation of certain chemical facts, and we must be careful not to accept the values for the atomic weights to which it points, unless confirmed by evidence derived from other sources. It must for the present be still regarded as a hypothesis, until it has been more fully developed, and until the anomalies which it contains have been explained."

We scarcely think that in discussing this law the editor has done full justice to Mr. Newlands.

We note the final sentence in Mr. Humpidge's preface:—"The range which the book covers is rather more than that required for the Intermediate Science and Preliminary Science Examinations of the London University, and the needs of students working for these examinations have been steadily kept in view, but without following the syllabus in a servile manner." In the original, as in German text-books in general, there is no reference to the examinations at any University. The student there is supposed to be working in order to know, not to pass. And the fact that he does know, and that we are obliged to import him to fill positions in this country, ought to convince us that our system is not the best.

The Health of the Senses. By H. Macnaughton Jones, M.D., &c. London: Longmans, Green, and Co.

We have here a very instructive and at the same time decidedly readable book, calculated to be of great public service. The author gives plain, intelligible directions for preserving the organs of the senses in a state of efficiency, and is insensibly led to considerations on the general health, especially of the nerve-centres. The teachings of this work turn of course mainly upon anatomical and physiological questions, and, of course, do not fall exactly within the ordinary scope of the Chemical News.

The introductory chapter on "preventive medicine" is exceedingly suggestive. The author shows the difficulty of impressing the general public with the importance of sanitary truths so long as the principles of physiology form no integral part of education. But he adds, too truthfully:—"The physiological laboratory and class may rather produce bad effects if the laws there taught and demonstrated are being daily broken by absurd school practices and rules which are framed rather for the ill-health than the health of the young. The thought may be encouraged that physiological precepts may be broken with impunity and a carelessness of attention to them engendered in after life."

The precautions needful for the preservation of sight are well worth attention,—the more as in some respects they run counter to popular prejudice. We are glad to find that he condemns the chimney-pot hat as utterly failing to screen the eye from the glare of sunshine. Dr. Macnaughton Jones is decidedly in favour of the electric light (incandescent) for domestic illumination in preference to gas, and that on the grounds that it gives out less heat and does not flicker. He refers to "the beautiful manner in which Mr. R. Hammond's house at Highgate is lighted by means of electricity."

In the chapter on hearing we find a much-needed caution on the dangerous practice of boxing the ears of children. The care of the skin, as the organ of feeling, naturally leads to certain lessons on cleanliness and on clothing. Tight-lacing and high-heeled boots meet here with a needed exposure. The results of both these follies may be seen illustrated by certain models in view at the Health Exhibition. The liver in the one case and the foot in the other is indeed a sorry sight. But, with the author, and in opposition to Miss Cobbe, we maintain that these malpractices are not due to the caprice of the male sex.

The last chapter is "A Word on Education." The author is an unsparing denouncer of "cram" in all its manifestations. In this respect, we must add, he is fairly

at one with the majority of the heads of the profession who have given the subject a full consideration.

There are very few educated persons who will not be the better for a careful perusal of this little book.

Bulletin of the Philosophical Society of Washington. Vol. IV. Containing the Minutes of the Society from Oct. 9th, 1880, to June 11th, 1881.

This bulletin, though bearing the date 1881, has been long delayed in its appearance.

Among the papers here given is one by Mr. C. Abbe on the altitude of the aurora, a question on which there prevails great difference of opinion. The present methods of measuring the height give only negative results. One method is based on the unproved assumption that the dip of the needle is the same in the upper regions of the air as on the earth's surface.

Prof. Ira Remsen has made on behalf of the National Board of Health an investigation on the organic matter in the air. He finds that air contaminated by being drawn through water containing decaying meat does not yield more than the usual quantity of albumenoid ammonia. On the other hand, air which has been drawn over comparatively dry decaying organic matter yields an abnormally large amount of albumenoid ammonia.

Professors Pumpelly and Smythe find that the removal of bacteria from liquids is very difficult; filtration through many feet of fine sand is not sufficient.

Vol. V., containing the Minutes of the Society from October 8, 1881, to December 16, 1882.

Mr. A. B. Johnson read a paper on the anomalies of sound from fog-signals. The author shows, as the result of a careful official examination, that while there is no lack in the volume of sound emitted by such signals, there is often a decided lack in the hearing of the sound, so much so that it is not heard with the intensity expected, nor at the place expected; it is heard faintly where it ought to be heard loudly, and loudly where it ought to be heard faintly; it is not heard at all at some points, and then further away it is heard better than when near; it is heard and lost, heard and lost again, all within a reasonable ear-shot and while the signal is in full blast.

The annual presidential address was delivered by W. B. Taylor, and was devoted to "Physics and Occult Qualities." The author discussed at great length the dynamic and kinematic theories of force, the theory of molecular kinetics, and the fallacy of kinematic theories. He maintains that force (energy) is "not a metaphorical abstraction; it is not a convenient asylum of ignorance. It is the potency and faculty whereby all inorganic, no less than organic, forms are builded. . . . . To the dynamics of even a single molecule the contestation and constraint of at least two opposite resisting agencies are indispensable. . . . . Nor is the certainty of multiplicity in the slightest degree impaired by our admitted ignorance as to the final number of primeval forces." In this connection he quotes Dr. Lodge, who in a lecture delivered at the London Institution, says: "To the question, what is electricity? we cannot assert that it is a form of matter, neither can we deny it; on the other hand, we certainly cannot assert that it is a form of energy, and I should be disposed to deny it." Professor Silvanus P. Thompson is also quoted as asserting, in his "Elementary Lessons in Electricity," that electricity, whatever it may prove to be, is not matter and is not energy."

Most of the remaining papers in this volume—some of them very important—treat on biological subjects.

Traité Pratique d'Analyses Chimiques et d'Essais Industriels. (Practical Treatise on Chemical Analyses and Industrial Assays.) By Raoul Jagnaux. Paris: Octave Doin.

This book, the author tells us, is designed not for the use of students, but of analysts, metallurgists, and other men of some experience. The majority of the methods given are said to be novel, some having been devised by the author's father, M. Hautefeuille, and some by the author himself. Among the novelties especial attention is called to the precipitation of copper by means of metallic lead. This method is especially recommended for the separation of copper from zinc, nickel, and cobalt. The author neutralises the acid which has served for dissolving the sample with ammonia, and filters if needful. The filtrate is then acidified with acetic acid, three or four plates of lead are added, and a gentle heat is applied. The lead dissolves and metallic copper is deposited. When the solution has become colourless, or retains merely a green colour, if nickel is present it is boiled for a few minutes and the capsule is removed from the fire; it is let settle, the clear liquid is then decanted off, and a little water added in order to prevent the copper from becoming oxidised. Any small quantity of copper remaining attached to the plates of lead is removed by friction with the fingers, and the lead is then put into a test-glass, moistened with a little acetic acid, rubbed with a rubbing brush over a capsule, and rinsed with the washing bottle in order to remove every trace of copper. After this operation the brush is washed in the water of the capsule. It is necessary not to heat the original solution immediately after the introduction of the plates of lead, lest the deposit of copper should adhere too strongly. It is therefore allowed to stand for a few minutes before applying heat; it is only when the plates are covered with a red coating that it can be safely heated. The metallic copper thus obtained is put in a test-glass and washed repeatedly with acetic acid and water in order to remove the small quantity of lead which remains attached to the copper. The liquid is decanted through a filter upon which the copper is received; it is then washed with boiling water and dried.

Into the filtrate there is then poured sulphuric acid, which precipitates the lead. It is let settle, filtered, washed, and the filter containing the lead sulphate is thrown away. The liquid is poured into a capsule, sulphuretted hydrogen water is added, and, on boiling, the last traces of copper and of lead are precipitated. The deposit is let settle and the clear liquid is filtered. The precipitated sulphides are placed in a glass with a little nitric acid, stirred up, and the glass is filled with sulphuretted hydrogen water in order to re-precipitate the trace of copper sulphide dissolved by the nitric acid. It is filtered and washed with sulphuretted hydrogen water.

The dry metallic copper (see above) is detached as completely as possible from its filter and placed in a phial. This filter and that containing the lead and copper sulphides is burnt and their ash is added to the copper contained in the phial and treated with dilute nitric acid. When all is dissolved the liquid is decanted into a capsule, mixed with ammonia and ammonium carbonate and boiled. The lead—both that entangled in the metallic copper and that from the sulphide—is precipitated, filtered off, and washed with care. The filtrate is placed in a capsule, acidified with nitric or sulphuric acid, mixed with oxalic acid in crystals, and boiled, when the copper is deposited as an oxalate.

The determination is then completed by the author's first method, which is used when no zinc, nickel, or cobalt is present.

The precipitate of copper oxalate is allowed to settle, the clear liquid is decanted, and the precipitate is received upon a filter. The filtrate and the decanted liquid are poured together and treated with a few drops of sulphuretted hydrogen water, in order to throw down the last traces of copper, boiled, and filtered. The copper oxalate is dried, detached as completely as possible from the filter, put in a small porcelain capsule, and ignited at a very gentle heat. It is thus converted into cupric oxide. The filter containing the sulphide and that from the oxalate are dried and burnt, their ash added to the copper oxide obtained above, and weighed.

But a small portion of the copper oxide is reduced during

the ignition, whence the substance weighed is a mixture. It is therefore placed in a porcelain capsule, mixed with water and a small quantity of sulphuric acid, and heated. The copper oxide dissolves, whilst the metallic copper remains untouched. It is let settle, washed repeatedly, received in a small porcelain capsule, dried, and weighed. Its weight is deducted from the weight obtained above. The remainder multiplied by 0·7982 and added to the small quantity of metallic copper obtained gives the total weight in metallic copper.

This method appears tedious, and there are no confirmatory analyses appended. We can scarcely admit that the greater portion of the processes indicated are, as stated in the preface, novel. Thus the determination of potassium and sodium salts and their separation is performed in the ordinary manner. In alkalimetry the author uses Gay-Lassac's burette, a standard solution of sulphuric acid, and litmus as indicator. For saltpetre the author gives merely the indirect method and the procedures of Riffaut and Pelouze. Baryta is directed to be determined by adding sulphuric acid in excess to the solution and boiling afterwards. Under phosphoric acid we find no mention of the molybdic method. There is an account of the magnesia process and of Joulie's modification of the uranium volumetric method. There are no special instructions for the frequent cases where phosphoric acid, in manures, phosphatic minerals, and soils, occurs along with alumina and iron. Alumina is determined by means of ammonia, with the well-known precautions, but there are no special instructions for its separation from iron until we come to the section on iron-ores. The separation is there directed to be performed by boiling in a silver capsule with caustic alkali in excess.

The separation of cobalt from nickel is effected by potassium nitrite in presence of acetic acid.

The author's chief strength is evidently metallurgy. His book is rich in instructions for the analysis of alloys, furnace products, slags, scoriæ, &c.

Several printing faults may be pointed out with a view to correction in any future edition. Thus we read that vermillion is adulterated with "coaltar," in place of "colcothar." A certain process is to be performed "*à chaux*," instead of "*à chaud*." For *per descensum* we have *per descendum*, &c. A good index would greatly add to the value of this book.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 20, May 19, 1884.

On Bromine-Substitutions.—MM. Berthelot and Werner.—The authors have found an order of compounds produced by substitution which may be formed in the calorimeter without the complication of secondary reactions. These are the bromine derivatives of the phenols. They have accordingly studied the formation-heats of these compounds at great length.

Transformation of Conicine into Propyl-pyridine, and Regeneration of the Conicine.—Dr. A. W. Hofmann.—On distilling conicine hydrochlorate with zinc-powder the author obtained a base which he names *congrine*, $C_8H_{11}N$, and which is ortho-propyl-pyridine. On heating this compound to 280°—300° in a sealed tube with concentrated hydriodic acid, conicine is reproduced.

New Method for Measuring the Intensity of an Electric Current in Absolute Units.—H. Becquerel.—The author has for some years been accustomed to measure the absolute intensity of a magnetic or electro-magnetic field by observing the rotation of the plane of polarisation of the light traversing a body placed in this field. He finds that this method is very easily applicable to the absolute measurement of an electric current.

On a Mercurial Galvanometer.—G. Lippmann.—A mercurial manometer placed under the influence of a magnet constitutes a very simple galvanometer, the indications by which are exactly proportional to the intensity of the current.

Variations of the Physical Properties of Bismuth Placed in a Magnetic Field.—M. Huron.—Dr. Kerr has already shown that a mirror of steel placed between the poles of an electro-magnet turns by a certain angle the plane of polarisation of a normal incident ray when the electro-magnet is animated. The rotation is produced in the inverse direction to that of the current effecting the animation. Bismuth possesses similar properties, as it appears from the author's experiments. The electric resistance of bismuth increases when it is placed in a magnetic field.

Expansion-Coefficients of the Elementary Gases.—J. M. Crafts.—Not adapted for useful abstraction.

Transmission of Sound by Gases.—M. Neyreneuf. The author finds that with coal-gas or with hydrogen sound undergoes a less diminution of intensity than in traversing the same stratum of air. This result is contrary to that shown in Leslie's experiment, but in this latter the vibrations were communicated from a solid body to the gas, and not, as in the present researches, from one gas to another.

Variation of the Indices of Refraction of Quartz under the Influence of Temperature.—H. Dufet.

Determination of Vapour-Densities by Gaseous Displacement under Reduced and Variable Pressure.—These two papers do not admit of useful abstraction.

Action of Potassium Sulphide upon Mercury Sulphide.—A. Ditte.—If precipitated mercury sulphide is placed in a strong cold solution of potassium sulphide a large quantity is dissolved. When the liquid is saturated the excess is transformed into transparent shining white needles, HgS,KS,7HO. In a hot solution the metallic sulphide is changed into brilliant golden-yellow plates of HgS,KS,HO.

On the Acid Barium Phosphates.—A. Joly.—The decomposition of barium mono-phosphate by water presents two successive phases. In the first, as the weight of the mono-baric salt goes on increasing in arithmetical progression, the weight of the salt which dissolves undecomposed decreases in geometrical progression. When about half the original salt has been decomposed the phenomenon changes, and there is formed in the liquid a bi-acid salt, the proportion of which increases along with the acidity of the liquid, and which at last remains alone.

Solubility of Salts.—M. Etard.—Not suitable for abridgment.

Ammoniacal Silver Chloride and Iodide in Crystals.—M. Terreil.—These compounds have the respective compositions—$AgCl,2NH_3$ and $AgI,2NH_3$.

An Artificial Pseudomorph of Silica.—A. Gorgen.—The author has obtained silica in the crystalline form of peridote. Its action upon polarised light is when dry that of a bi-refringent crystal, and when immersed in water that of a mono-refringent body.

Analysis of the Mineral Water of Brucourt.—Ch. Cloëz.—The properties of this water depend on ferrous and magnesian salts and on iodides.

The Agricultural Use of Superphosphates.—M P. P. Dehérain.—The author urges that in order to foretell the action of superphosphates upon a soil, it is not sufficient to determine the total quantity of phosphoric acid. We must also ascertain with what bases it is combined.

Comparative Nitrifying Action of Certain Salts Contained in or added to Vegetable Soil.—M. Pichard.—Taking the nitrifying action of gypsum as 100, that of sodium sulphate is 47·91, that of potassium sulphate 35·78, and that of magnesium carbonate 12·52. The nitrifying power of gypsum explains its useful action on lucerne. The power of the lime salts justifies the ancient practice of marling.

Bulletin de la Société Chimique de Paris.
No. 6, March 20, 1884.

Russian Chemical Society: Proceedings of the Chemical Section of the Russian Congress of Naturalists and Physicians held at Odessa.—Aug. 19th to 31st, 1883.—M. Brauner made a communication on the atomic weights of cerium, didymium, and tellurium. The values found agree better with the periodic system than the numbers as determined by other chemists.

M. Petrieff has studied the isomerism of fumaric and maleic acids and the action of zinc-ethyl upon the neutral ether of fumaric acid.

Session, August 20th.—M. Petrieff read a memoir on a new group of colouring compounds derived from aniline. On submitting aniline hydrochlorate to the action of an aqueous solution of potassium nitrite he obtains a crystalline body, $C_{18}H_{18}N_4$, fusible at 95°, and soluble in several liquids. The salts are decomposed by water. This compound dyes silk and cotton a golden yellow. If melted with aniline hydrochlorate it forms a compound, $C_{30}H_{26}N_4$, which dyes silk and cotton a blue, and another product, probably $C_{24}H_{22}N_4$, which dyes violets. If melted with α-naphthol it gives a light orange body, $C_{28}H_{27}N_4$, and with β-naphthol an orange-red product.

M. Petrieff made also a communication on bone-oils.

M. Albitzky has studied the β-dipropyl-acrylic acid obtained by the acid of sulphuric acid and phosphorus terchloride upon β-dipropyl-ethyleno-lactic acid.

M. Lupatkine has obtained a chlorinised alcohol by causing zinc and allyl-iodide to react upon epichlorhydrine.

M. Chestakoff, in preparing diallyl-carbinol has obtained a product boiling between 207° to 215°, and which appears to be diallyl-carbinol in which an atom of H is replaced by a propyl group.

M. Chatzky has obtained allyl-dimethyl-carbinol in which an atom of hydrogen is replaced by the group C_4H_9 by causing a mixture of allyl-iodide and of primary isobutyl-iodide to react upon acetone in presence of zinc.

M. Melikoff described the result of his researches on the homologues of glycidic acid.

Session, August 22nd.—M. Beketoff communicated the result of his researches on lithium oxide.

M. Ponomareff has studied the action of caustic potassa upon the product obtained by Grimaux on melting urea with parabanic acid.

M. Reoformatsky has obtained a hydrocarbon, C_8H_{14}, on treating allyl-diethyl-carbinol with dilute sulphuric acid.

M. Albitzky has studied the specific refractive energy of the hydrocarbon $C_{12}H_{20}$ obtained by means of allyl-dimethyl-carbinol.

M. P. Alexeeff proposes a new constitutional formula for indigo blue.

Session of August 27th.—M. Glinska explained the results of his researches on magnetic iron oxide in efflorescence and the metamorphosis of minerals containing pyroxenes and olivines.

M. Chechoukoff sent in a memoir on the action of chlorine upon isobutylen.

M. Timofeeff examined the yield of hydrocarbons obtained on causing an alkaline alcoholic solution in excess to react upon the chlorides, bromides, and iodides of the ethylic, propylic, isopropylic, and isobutylic alcohols of trimethyl-carbinol of the amylic alcohol of fermentation, and of dimethyl-ethyl-carbinol.

M. Dieff made a communication on the double decompositions between silver oxide and the haloid salts of sodium in an aqueous solution.

M. Petrieff has studied the action of an alcoholic solution of caustic potassa upon epichlorhydrin.

MM. Petrieff and Okolowitsch have studied the action of sodium amalgam upon phenosic trichlorhydrin.

M. P. Alexeeff has undertaken a series of researches on the azocuminic acid.

Session of August 28th.—M. Tchirikoff has studied the action exerted by the presence of certain mineral substances upon the results of the elementary analysis of coal; the action of carbonic acid upon lead peroxide at high temperatures, which, according to the author, does not yield lead carbonate, and the variations of the weight of coal at high temperatures.

M. Pavloff made a communication on tartaric acid.

M. Kissel read a paper on the nitro-derivatives of the fatty series.

M. Ponomareff has studied the ethers of cyanuric acid and its constitution.

Session of August 29th.—M. Betz has found that the sensitiveness of silver bromide to light is increased by allowing it to crystallise in a solution of pure isinglass, and drying at 10° to 12°.

M. Petrieff has studied the double decompositions of salts and determined the relation of the carbonates of calcium, strontium, barium, zinc, cadmium, lead, and silver to the nitrates of the same metals.

M. Hemilian sent in a communication on diphenyl-paraxylyl-methane and its oxidation products.

M. Harnitzky has studied the action of a mixture of acetylene and carbon monoxide upon a solution of cuprous chloride.

M. Beketoff made a communication on the relation between the dissociation heat, the formation-heat, and the relative weights of the combined atoms.

Meeting, September 15th to 27th.—M. Menschoutkine communicated the following researches made in the laboratory of the University of Kazan:—By M. Albitzky, on the β-dipropyl-acrylic acid obtained in setting out from β-dipropyl-ethyleno-lactic acid. By M. Lopatkine, on the action of allyl iodide and zinc on epichlorhydrin. By M. Chestakoff, on the accessory product obtained in the preparation of diallylcarbinol. By M. Chatzky, mentioned above. By M. Reformatsky, mentioned above. By M. Kanounikoff, on the relation between the specific refractive energy of chemical compounds and their composition.

M. Potilitzine sent in a communication on the velocities of chemical reactions.

M. Zaboudsky made a communication on the hydrated silica obtained with cast-iron.

M. Konovaloff gave certain thermic data on pyrosulphuryl chloride.

M. Alexeeff explained his theory on the nature of solutions.

M. Flavitsky stated his mechanical theory of the reciprocal chemical action of the atoms of the elements.

M. Brauner gave the atomic weight of tellurium as 125, which agrees with the place assigned to it in the periodic system.

MEETINGS FOR THE WEEK

Wednesday, 25th.—Society of Arts, 4. (Anniversary).
—— Geological, 8.
Friday, 27th.—Quekett Microscopical Club, 8.
Saturday, 28th.—Physical, 3.

TO CORRESPONDENTS.

Wm. Younger.—You will probably find the most suitable information in the monthly numbers of *The Sugar Cane.*

THE CHEMICAL NEWS.

Vol. XLIX. No. 1283.

FARMYARD MANURE: A MEDIUM FOR THE DEVELOPMENT OF PARASITIC DISEASES.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, Silver and Bronze Medallist in Chemistry, &c.

This memoir intends to detail some recent researches on farmyard manure as a medium for the development of certain parasitic diseases. Although this time-honoured manure has been looked upon as one of, if not the best, fertiliser known to the cultivator of the soil, yet I wish to show that it may under certain conditions be the means indirectly of destroying his crops instead of feeding them. I took some fresh excrements of the horse, placed them in a dish, and then added a little distilled water, stirred the mixture round with a glass rod, and examined a drop of the liquor under the microscope. I was unable to discover any organisms, but on allowing the dish with its contents to stand 48 hours exposed to the air, and then examining, microscopically, I found it full of life—rod-like bodies endowed with the power of active movement; whereas 48 hours previously all was quiet in the little drop under the microscope. By this examination I was able to distinguish several forms of *Schizomycestes*, namely, bacteria, bacilli, vibrios, &c. Further than this, these researches show that farmyard manure is a medium in which the *Peronospora infestans* can live to a certain extent, for I have transplanted *Peronospora infestans* from *Solanum tuberosum* (potato), to a quantity of moistened farmyard manure, and kept it in this medium for about two days in a warm place. On examination with the microscope, the mycelia of this parasitic organism had ramified in all directions throughout the little mass of manure. So far I have only been able to see *Peronospora* continue this growth of hyphæ of its life-history, and no further. Although I have spent a large amount of time and labour on this most important investigation, I have been unable to witness the production of conidia-bearing branches and gonidia. In fact, the "parasite" in this medium seems only to continue throwing out hyphæ *ad infinitum*. The remaining part (*i.e.* gamogenesis, and the production of oospores) of the life-history of *Peronospora*, as far as I am capable of judging, up to the present time, seems impossible in this medium, although when oospores are transferred from the potato to a fresh piece of moist farmyard manure, they will, on rising the temperature to about 60° C., "germinate," and throw out hyphæ as already described. From these investigations, which were conducted with the greatest possible care, it will be seen that *Peronospora* can live to a certain extent in other media besides the potato; but, the important bearing of this research is to show that farmyard manure may, under certain conditions and circumstances, become the medium for spreading parasitic diseases amongst our crops. I have shown that the potato disease will grow to a certain extent in farmyard manure, and i oospores of the *Peronospora* are wafted by winds, and ultimately fall into this medium which nourishes them, they are ready to attack our potato crops when placed in the land containing this farmyard manure, which may already be diseased. Although the agriculturist has a kind of reverence for this manure, yet it may be possible that it does more harm than good, and other diseases, common to plants, may thrive well in this medium. It may not be too revolutionary to prophesy that the agriculturist of days to come will turn his back on this time-honoured "plant-food" of his forefathers, and will see the advantages of giving his crops sweeter and better foods to subsist on than this food, which is, according to some chemists, of very little value. Quoting from a recent investigator,—"farmyard manures are *not* sufficient even to restore to the constantly cultivated soils what has been taken out in the crops." Farmyard manure may contain all the ingredients which plants extract from the soil, but it also pleads guilty to containing no less than 95 per cent of carbohydrates, of which some chemists are of the opinion that there is already a superabundance in the soil. Therefore if there are 95 cwts. of useless stuff in every 100 cwts. of the manure, what is the use of running the risk of producing diseases in our crops by applying such a poor food to the land? The Chinese, who are the most admirable agriculturists in the world, attach very little value to the excrements of animals as manures; and M. D'Avéne ("*Biedermann's Centralblatt für Agricultur-chemie*," 1883, 643), has cultivated crops for fourteen years with great success without farmyard manure, employing only artificial manures.

Another argument against the use of farmyard manure is that by its use we are apt to cover our fields and plots of land every year with weeds, for the seeds of weeds are taken up by grazing cattle, and these seeds pass through the alimentary canal undigested along with other waste products; these germinate, and the farmer wonders "where all the weeds come from." It is well known, as Liebig* said years ago, "the fertility of a soil cannot remain unimpaired, unless we replace in it *all* those substances of which it has been deprived" by the growth of the crop. This fertility can be entirely kept up by the judicious use of the numerous artificial manures, for in the words of that celebrated chemist just quoted "plants cannot live unless supplied with certain metallic compounds."

These compounds being the bases of our artificial manures, by their use we do not run the risk of adding a substance to the soil which is a medium for the growth and development to a certain extent of parasitic disease, as is the case when we use farmyard manure.

From these investigations it will be seen that the cultivator of the soil has been encouraging disease, if not directly adding it to his land.

I have found that the temperature between 30° and 60° C. is most favourable for the growth of hyphæ of *Peronospora* in farmyard manure. M. Déhérain (*Comptes Rendus*, vol. xcviii., No. 6, Feb. 11, 1884), has shown that marshgas is the product of an organised ferment in farmyard manure, and it may be possible that his organised ferment is one of the fungi.

Referring again to the observation already alluded to, namely, that bacteria and other micro-organisms develope in farmyard manure, I have experimented with various mineral compounds which delay or altogether prevent the development of these organisms. It is important, however, to observe that these low forms of life are themselves much more susceptible to these and similar influences than are the spores or germs which seem to resist almost everything. But I have found that there are certain compounds which destroy completely these bacteria. Examining under the microscope a warm infusion of farmyard manure in which there were numerous bacteria growing and multiplying, I found that running in solutions of the following salts completely destroyed the organisms and the spores:—Ferrous sulphate, 0·0269 grm., minimum quantity in 100 grms. of water; cupric sulphate, 0·0073 grm.; and sodium chloride, 5·000 grms., minimum quantities respectively in 100 grms. of water.

As these mineral compounds are all used now as manures, &c., for certain crops, it will be seen that they are useful not only as direct foods for the plant, but are antiseptic agents completely destroying bacteria in farmyard manure, and it is most probable that they will destroy other parasitic forms which are enemies to our crops. I am aware that the investigations of A. Riche

* "Organic Chemistry in its Applications to Agriculture and Physiology," page, 174.

(*Journal de Pharmacie et de Chemie*, vol. viii., Nov., 1883), have shown that the vitality of one and the same micro-organism varies extremely according to the medium in which it lives. These growths may be killed by the solutions mentioned when growing in the infusion, yet live when treated with the same antiseptic solutions when growing in other media.

Whether these mineral compounds act in any way on the *Peronospora* and other parasitic fungi which destroy our crops, I am unable to say at present, but intend to thoroughly investigate this important problem.

THE PHYSICAL AND CHEMICAL ANALYSIS OF FLOUR.*

By ALBERT R. LEEDS.

(Concluded from page 273.)

DURING the course of the chemical analyses previously detailed trial was made of the various methods for the analysis of flour heretofore proposed. Attempts were made to substitute direct for indirect determination of several constituents, and at the same time to effect a gain in rapidity of working and in accuracy of results. These attempts have been only in part successful. And inasmuch as the difficulties to be overcome can be best explained in connection with the trials of previous methods, the results of these trials will be stated first.

A. *Cairn's Method* ("*Quantitative Analysis*," *p.* 255).

"Digest 5 grms. of the flour in 100 c.c. cold water for one or two hours, with frequent stirring, filter through a filter previously exhausted with hydrochloric acid, washed, dried, and weighed; wash with about 100 c.c. cold water. The solution contains:—(1) *albumen*, (2) *gum*, (3) *sugar* and a portion of the soluble salts. The residue contains:—(4) *celluloses*, (5) *starch*, *gluten*, and *fat*."

"*Solution.*—1. Boil, and then filter; the precipitate consists of albumen, Dry at 100°, and weigh.

"The treatment with water, filtration, and precipitation of albumen should be completed on the same day. By keeping the solution hot it may be continued through two days, but this is not advisable."

[These are tedious operations, and of questionable accuracy. Granting that the solution of gum, soluble albumen, and sugar is perfect, nevertheless complete washing by this method is troublesome to effect.]

The precipitation of the albumen on boiling so dilute a solution is also imperfect. In an actual trial, even after concentrating the solution to one-half and boiling, only 37 per cent of the soluble albumen was precipitated. On evaporating to 40 c.c. an additional precipitate of 52 per cent was obtained, and to 15 c.c. a third precipitate of 0·4 per cent. It is not only necessary to collect these precipitates of albumen on weighed filters, but to boil down in tared beaker glasses, because the coagulated albumen attaches itself to the sides of the beaker, and cannot be perfectly detached. These three determinations of soluble albumen required, therefore, nine weighings in all, and the final result was incorrect, falling short of the correct result by 7 per cent of the amount actually present.

The albumen so obtained should be ignited, and its amount of ash deducted.

"2. Evaporate the filtrate from the albumen nearly to dryness, add a large excess of alcohol, warm, and then allow it to cool; filter on a weighed filter; wash with alcohol. Dry at 100° C., and weigh the gum thus obtained."

[NOTE.—The gum thus precipitated carries down with it some saline matters, and it should be ignited, and the weight of ash deducted.]

"3. Evaporate the alcoholic filtrate from the gum to small bulk, add water, and boil out the alcohol. Concentrate the solution to 50 c.c., and divide into halves. In the first half determine the dextrose directly by copper sulphate solution. In the second half add a few drops of dilute sulphuric acid, boil, neutralise with potassium hydrate, and determine dextrose as before. The excess of dextrose found in the second solution is due to cane-sugar."

"*Residue.*—Wash with a jet from the wash-bottle into a beaker. Then dry the filter with what adheres to it and weigh. This weight, less that of the filter found at the beginning, gives the weight of adhering substance, which must be taken into account in the subsequent determinations."

[NOTE.—Although the amount left behind is small—in a trial only 0·0815 grm. out of an original weight of 5·3005 grm.—yet this filtration is very tedious, and requires two additional weighings.]

"4. Add to the substance in the beaker 50 times its weight of water, containing one per cent of sulphuric acid, and heat for several hours, until the starch goes into solution, and only light flocculent cellulose is left. Filter and wash until all sulphuric acid is removed, dry at 100° and weigh."

[NOTE.—All the albumenoids and starch are not carried into solution by this method, and the weight of cellulose so obtained much exceeds the true amount. The excess, as determined in one trial, was five times. The so-called cellulose when submitted to chemical treatment under the microscope was found to have unruptured cells, containing starch granules and undissolved albumenoid bodies.]

"5. To the filtrate from the cellulose, diluted to 400 c.c., add about 30 c.c. concentrated sulphuric acid, and heat on a water-bath at about 95° for several hours, adding water from time to time to keep it up to the original bulk. Digest this until a drop of the solution shows no colouration when heated with diluted iodine solution, and also gives no precipitate with alcohol. When the conversion of the starch into dextrose is complete, neutralise the excess of acid by sodium or potassium hydrate, and determine the glucose with copper sulphate as before."

[NOTE.—It has been shown by Allihn (*J. pr. Chem.*, xxii., 50), and by Salomon that the conversion effected by means of sulphuric acid is only partial, the former authority stating that under the conditions which usually prevail in starch analyses only 95 per cent of the starch is converted into dextrose. In an experiment in which the results obtained with sulphuric acid were compared with those obtained by means of hydrochloric acid, when used according to Sachse's method (*Chem. Centr.*, 1877, 732), to be given later, I obtained a less discrepant result. Sulphuric acid yielded 98 per cent of the amount as determined by hydrochloric acid.]

"The starch can also be determined in a separate portion by washing a weighed quantity with water, then with ether, and again with water, drying and then making an elementary analysis for carbon. The carbon found is from both starch and cellulose. Deduct the carbon due to cellulose found as above (formula, $C_{12}H_{10}O_{10}$, the same as that of starch), and calculate the rest to starch (44 parts carbon = 100 parts starch)."

[NOTE.—This method is tedious, difficult of execution, and inaccurate. After washing with water and ether, and drying as directed, a tough horny cake was left in the filter-paper, consisting, in addition to the starch and cellulose, of the insoluble gluten, &c. The physical qualities of this mass were such that it could not be detached from the filter. Even had it been possible to do so, the percentage of one ingredient (the starch) could not have been estimated from a carbon determination, when besides the cellulose, a mixture of at least four substances, such as are present in varying amounts in crude gluten, were undetermined.]

* Advance sheets communicated by the author. Reprinted from the *Journal of the American Chemical Society*, vol. vi., No. 3.

"*Albumenoids.*— Determine the total nitrogen in 1 grm. by combustion with soda-lime, and from this calculate the albumenoids; 15·5 parts N = 100 parts albumenoids. From this deduct the albumen found as above; the difference is gluten."

[Note.—It has already been shown that the percentage of albumen found as above is only a fraction of the amount actually present. The ratio of 15·5 : 100 gives for the nitrogen multiplier 6·45. This is certainly too high. Ritthausen concluded from the results of his elaborate analyses of the wheat albumenoids, that the correct multiplier is 6. Others place it at 6·33, and this number has been employed in making the calculations contained in the present article, except where otherwise stated.]

"*Fat.*—Weigh out 2 or 3 grms., treat with ether, boiling it gently over the water-bath, decant the ether through a filter into a weighed dish, repeat this two or three times, evaporate off the ether, and weigh the fat."

[Note.—This method of fat extraction gives results much too low. As thus determined, the Pillsbury flour contained only 1·02 per cent of fat. When the treatment of ether was continued until no more fat could be extracted, the sample of flour (undried) yielded 1·35 per cent of fat; dried, it yielded 1·31 per cent. These latter results are in accordance with those stated by König ("Nahrungsmittel," p. 559), who recommends that the extraction with ether should be performed on the dried substance rather than on the undried, the latter method usually yielding the higher results. This he attributes, not so much to a decomposition and alteration of the fat, but to a solution in water-holding ether of substances other than fat—such as resin, wax, chlorophyll, &c.].

"*Ash.*—Burn 40 or 50 grms. of the flour in a weighed dish. If there is any difficulty in burning off the carbon, cool and weigh the dish and contents; then extract with hot water, filter through a small filter, avoiding any transfer of the carbonaceous substance to the filter. Dry the dish, and weigh again. The loss represents mineral salts dissolved out. Moisten with nitric acid, add the filter-paper and contents, burn again, cool, and weigh. The weight, less that of the dish, represents the remainder of the ash. The weight of the ash of the small filter-paper may be ignored. The ash may be dissolved in water with a little nitric acid, and analysed as required."

[Note.—This amount of flour appears enormously greater than needed, except it be desired to make an extended analysis of the ash. In an actual trial 22,9435 grm. flour was taken, and burned in a platinum capsule, with a small flame placed somewhat to one side of the dish. The platinum was raised to a red heat only, and contact of a current of heated air with the carbonised mass was favoured by this disposition of the flame. At the end of 8 hours I was surprised to find that the ash was burned perfectly, no carbon remaining.]

An accurate method is given by König ("Nahrungs- und Genussmittel," p. 316 and 561). Ten to twenty grms. of the flour is burned, at first over a small flame, until a black coal remains, and no more smoke is given off. Then the flame is removed, the coal pulverised, and allowed to stand for some hours in the air. On now strongly igniting, a very white ash is quickly obtained, or, if necessary, the exposure to air and ignition may be repeated. This gives the raw ash, which may contain coal, sand, and carbonic anhydride, and is not to be set down as the pure ash or "ash."

To correct for carbonic anhydride, the entire raw ash (from 10 to 20 grms. of substance) is dissolved by hydrochloric acid in a CO_2 apparatus, and its amount subtracted.

The solution so obtained is filtered upon a dried tared filter, repeatedly washed with hot HCl, then with hot Na_2CO_3 and NaHO, in order to remove separated silica, then again with hot water, dried at 100° to 110°, and weighed. This residue of coal and sand is then to be deducted from the raw ash.

König says truly that CO_2 in the ash of pure cereals is too inconsiderable to necessitate a correction for it. If the ash does evolve notable CO_2, it indicates an addition of chalk, magnesite, &c.

In nice questions, involving falsifications of the flour, the above method is advisable. But for ordinary determinations a very simple and rapid method, which is given later, will be found accurate.

(To be continued.)

ON THE USE OF TUBES OF COLOURED GLASS FOR NESSLERISING.*

By A. A. BRENEMAN.

The idea of using the ordinary amber-coloured window glass of different shades to furnish a series of standard tints for use in the Nessler ammonia test, occurred to me several years ago, and a note upon the subject was read at the Boston meeting of the American Association in 1880. Since then I have found, however, that the suggestion was not essentially new, and the method proposed, moreover, that of holding a slip of glass of the desired tint over the mouth of a Nessler test-tube filled to the mark with clear water while the tube containing the unknown quantity of ammonia is held by the side of the test-tube for comparison, is open to objection. The fact that light coming to the eye after passing through the length of the comparison tube is modified by reflection at the surface of the coloured glass, as also the fact that the coloured media in the two tubes have their upper surfaces respectively in different planes and at different distances from the eye, both tend to prevent a satisfactory comparison of the two tints. While these difficulties might be corrected, in part at least, by surrounding each tube with a blackened sheath or case, it has seemed more in accordance with the ordinary method of making the Nessler test and with the principles of colorimetry in general, to introduce the coloured medium below the comparison tube. The light from this coloured medium should be applied in connection with a tube precisely like the comparison tube and filled to the mark with clear water; in no other way can the *quality of illumination*, which is essential to a fair comparison, be obtained. The suitability of glass as the coloured medium is simply a question of securing the proper tints. Its cleanliness, uniformity, and fixity of tint render it far superior to any other substance that could be applied to this purpose. It was mentioned in the note referred to that the tints of commercial amber glass corresponded very well with the higher values needed among the Nessler standards, such for example as the tints given by 1 c.c. of Wanklyn's weak solution of ammonia (1 c.c. = 0·00001 grm. NH_3), but it was found difficult to obtain glass matching the tints given by smaller quantities of ammonia and for values under 0·5 c.c. of the standard solution; no glass of tint sufficiently light could be found. Even "flashed" glass which might be supposd to yield lighter tints than "pot-coloured" glass, is still too dark for the purpose. The manufacture of glass is too costly an operation to permit of experiments being made upon special "batches" of glass made for the purpose, unless some manufacturer could be inspired with a scientific interest in such work, or were given an order large enough to warrant the attempt as a matter of business. Failing in this direction, it occurred to me that a tube made from glass of the proper tint might answer the purpose, and the fact that the bottom of such a tube would be *blown* suggested the means of varying its thickness, and therefore its tint, to any desired extent. Such a tube was found, however, to be unsuitable for comparison with the colour of Nesslerised liquids, because the yellow

* *Journal of the American Chemical Society*, vol. vi., No. 4.

light coming through the sides of the tube increased the colour given to the light coming through the bottom, and even when filled with clear waters the quality of illumination in the two tubes was such as to forbid comparison. The only suitable condition seems to be that in which the light enters the tube through the coloured medium placed at or very near the bottom of the tube. The sides of the tube should be of colourless glass, and the tube filled with clear water as mentioned above. These conditions seem to be best fulfilled by such tubes as are shown here, for which I am indebted to the co-operation of a skilful glass-blower, Mr. William Baetz. A short length of amber glass tubing is fused to a longer piece of colourless tubing to form a tube like those used in Nesslerising. The bottom is flat, and the coloured portion forms about one-fifth of the entire tube. It is a matter of some difficulty to find glass of proper composition to adhere readily to the amber glass, and still more so to extend the coloured part of the cylinder by blowing without altering its diameter. Both results have been fairly accomplished, however, and slight defects shown in these tubes will be removed, no doubt, after practice in making them. It is possible, then, to start with glass tubing of a given shade and to weaken the tint by blowing out the tube until the desired tint is reached. The tube is then closed and flattened at the desired distance from the junction with the colourless glass. In practice I have found it more simple to have a number of such tubes made of various shades below a certain one, and to pick out from these such as corresponded exactly with the different tints given by the Nessler reagent with known quantities of ammonia. It has been my custom for years in using Wanklyn's method of water analysis to distil off 10 c.c. at a trial, using only 100 c.c. of the water to be tested, and all of these tubes have been made of the 10 c.c. size, but the principle is perhaps more easily applicable to larger tubes, because the variations of tints required would be less delicate. For very light shades I have found an amber glass with a barely perceptible olive tint to yield the best results when distended and weakened in colour as described. It should be said, finally, that the junction of the compound tube causes an unavoidable *ringed* appearance in the tube when filled with water, but with a well-made bottom to the tube there is always a clear space within the innermost circle sufficiently large to permit of comparison with the tint of the other tube.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

CERIUM.

ALTHOUGH cerium was discovered almost at the beginning of the present century, its atomic weight was not properly determined until after the discovery of lanthanum and didymium by Mosander. In 1842 the investigation was undertaken by Beringer,† who employed several methods. His cerium salts, however, were all rose-coloured, and therefore were not wholly free from didymium; and his results are further affected by a negligence on his part to fully describe his analytical processes.

First, a neutral solution of cerium chloride was prepared by dissolving the carbonate in hydrochloric acid. This gave weights of ceroso-ceric oxide and silver chloride as follows. The third column shows the amount of CeO_2 proportional to 100 parts of AgCl:—

CeO_2.	AgCl.	Ratio.
0·5755 grm.	1·419 grms.	40·557
0·6715 ,,	1·6595 ,,	40·464
1·1300 ,,	2·786 ,,	40·560
0·5366 ,,	1·3316 ,,	40·297

Mean 40·469 ± 0·0415

The analysis of the dry cerium sulphate gave results as follows. In a fourth column I show the amount of CeO_2 proportional to 100 parts of $BaSO_4$:—

Sulphate.	CeO_2.	$BaSO_4$.	Ratio.
1·379 grm.	0·8495 grm.	1·711 grm.	49·649
1·276 ,,	0·7875 ,,	1·580 ,,	49·836
1·246 ,,	0·7690 ,,	1·543 ,,	49·838
1·553 ,,	0·9595 ,,	1·921 ,,	49·948

Mean 49·819 ± 0·042

Beringer also gives a single analysis of the formate and the results of one conversion of the sulphide into oxide. The figures are, however, not valuable enough to cite.

The foregoing data involve one variation from Beringer's paper. Where I put CeO_2 as found he puts Ce_2O_3. The latter is plainly inadmissible, although the atomic weights calculated from it agree curiously well with some other determinations. For instance, in the chloride series, the assumption of Ce_2O_3 as the formula of the oxide obtained, gives Ce = 137·749, while CeO_2 makes Ce = 141·636. The former agrees with the results of Wolf, Wing, and others quite fairly; the latter is near the value obtained by Bühring. Obviously, the presence of didymium in the salts analysed should tend to raise rather than to lower the apparent atomic weight of cerium.

Shortly after Beringer, Hermann* published the results of one experiment. 23·532 grms. of anhydrous cerium sulphate gave 29·160 grms. of $BaSO_4$. Hence 100 parts of the sulphate correspond to 123·926 of $BaSO_4$.

In 1848 similar figures were published by Marignac,† who found the following amounts of $BaSO_4$ proportional to 100 of dry cerium sulphate:—

122·68
122·00
122·51

Mean 122·40 ± 0·138

If we give Hermann's single result the weight of one experiment in this series, and combine, we get a mean value of 123·019 ± 0·113.

Still another method was employed by Marignac. A definite mixture was made of solutions of cerium sulphate and barium chloride. To this were added, volumetrically, solutions of each salt successively, until equilibrium was attained. The figures published give maxima and minima for the $BaCl_2$ proportional to each lot of $Ce_2(SO_4)_3$. In another column, using the mean value for $BaCl_2$ in each case, I put the ratio between 100 parts of this salt and the equivalent quantity of sulphate. The latter compound was several times re-crystallised:—

	$Ce_2(SO_4)_3$. Grms.	$BaCl_2$. Grms.	Ratio.
First crystallisation ..	11·011	11·990—12·050	91·606
,, ,, ..	13·194	14·365—14·425	91·657
Second ,, ..	13·961	15·225—15·285	91·518
,, ,, ..	12·627	13·761—13·821	91·559
,, ,, ..	11·915	12·970—13·030	91·654
Third ,, ..	14·888	16·223—16·283	91·602
,, ,, ..	14·113	15·383—15·423	91·755
Fourth ,, ..	13·111	14·270—14·330	91·685
,, ,, ..	13·970	15·223—15·283	91·588

Mean 91·625 ±0·016

* Smithsonian Miscellaneous Collections. "The Constant of Nature."
† *Ann. Chem. Pharm.*, 42, 134.

* *Journ. f. Prakt. Chem.*, 30, 185. 1843.
† *Arch. des Sci. Phys. et Nat.*, (1), 8, 273. 1848.

Omitting the valueless experiments of Kjerulf,* we come next to the figures published by Bunsen and Jegel† in 1858. From the air-dried sulphate of cerium the metal was precipitated as oxalate, which, ignited, gave CeO_2. In the filtrate from the oxalate the sulphuric acid was estimated as $BaSO_4$:—

Grm.		Grm.		Grm.
1·5726 sulphate gave		0·7899 CeO_2 and		1·6185 $BaSO_4$.
1·6967	,,	0·8504	,,	1·7500 ,,

Hence, for 100 parts $BaSO_4$, the CeO_2 is as follows:—

48·804
48·575

Mean 48·689 ± 0·077

One experiment was also made upon the oxalate:—

0·3530 grm. oxalate gave 0·1913 CeO_2 and 0·0506 H_2O.

Hence in the dry salt, we have 63·261 per cent of CeO_2.

In each sample of CeO_2 the excess of oxygen over true Ce_2O_3 was estimated by an iodometric titration; but the data thus obtained need not be further considered.

In two papers by Rammelsberg‡ data are given for the atomic weight of cerium as follows. In the earlier paper cerium sulphate is analysed, the cerium being thrown down by caustic potash, and the acid precipitated from the filtrate as barium sulphate:—

Grm.		Grm.		Grm.
0·413 $Ce_2(SO_4)_3$ gave		0·244 CeO_2 and		0·513 $BaSO_4$.

Hence 100 $BaSO_4$ = 47·563 CeO_2, a value which may be combined with others, thus; this figure being assigned a weight equal to one experiment in Bunsen's series:—

Beringer	49·819 ±	0·042
Bunsen and Jegel	48·689	0·077
Rammelsberg	47·563	0·108
General mean ..	49·360	0·035

It should be noted here that this mean is somewhat arbitrary, since Bunsen and Rammelsberg's cerium salts were undoubtedly freer from didymium than the material studied by Beringer.

In his later paper Rammelsberg gives these figures concerning cerium oxalate. 100 parts gave 10·43 of carbon and 21·73 of water. Hence the dry salt should yield 48·862 per cent of CO_2, whence Ce = 137·83.

In all of the foregoing experiments the ceroso-ceric oxide was somewhat coloured, the tint ranging from one shade to another of light brown according to the amount of didymium present. Still, at the best, a faint colour remained, which was supposed to be characteristic of the oxide itself. In 1868, however, some experiments of Dr. C. Wolf‖ were posthumously made public, which went to show that pure ceroso-ceric oxide is white, and that all samples previously studied were contaminated with some other earth, not necessarily didymium, but possibly a new substance, the removal of which tended to lower the apparent atomic weight of cerium very perceptibly.

Cerium sulphate was re-crystallised at least ten times. Even after twenty re-crystallisations it still showed spectroscopic traces of didymium. The water contained in each sample of the salt was cautiously estimated, and the cerium was thrown down by boiling concentrated solutions of oxalic acid. The resulting oxalate was ignited with great care. I deduce from the weighings the percentage of CeO_2 given by the *anhydrous* sulphate:—

Sulphate.	Water.	CeO_2.	Per cent CeO_2.
1·4542 grm.	0·19419 grm.	0·76305 grm.	60·559
1·4104 ,,	0·1898 ,,	0·7377 ,,	60·437
1·35027 ,,	0·1820 ,,	0·70665 ,,	60·487

Mean 60·494 ± 0·024

After the foregoing experiments the sulphate was further purified by solution in nitric acid and pouring into a large quantity of boiling water. The precipitate was converted into sulphate and analysed as before:—

Sulphate.	Water.	CeO_2.	Per cent CeO_2.
1·4327 grm.	0·2733 grm.	0·69925 grm.	60·311
1·5056 ,,	0·2775 ,,	0·7405 ,,	60·296
1·44045 ,,	0·2710 ,,	0·7052 ,,	60·300

Mean 60·302 ± 0·004

From another purification the following weights were obtained:—

1·4684 grm. 0·1880 grm. 0·7717 grm. 60·270 per cent.

A last purification gave a still lower percentage:—

1·3756 grm. 0·1832 grm. 0·7186 grm. 60·265 per cent.

The last oxide was perfectly white, and was spectroscopically free from didymium. In each case the CeO_2 was titrated iodometrically for its excess of oxygen. It will be noticed that in the successive series of determinations the percentage of CeO_2 steadily and strikingly diminishes, to an extent for which no ordinary impurity of didymium can account. The death of Dr. Wolf interrupted the investigation, the results of which were edited and published by Professor F. A. Genth.

The experiments of Wolf seem to have hitherto escaped general notice, except from Wing, who has partially verified them.* This chemist, incidentally to other researches, purified some cerium sulphate after the method of Wolf, and made two similar analyses of it, as follows:—

Sulphate.	Water.	CeO_2.	P. c. CeO_2.
1·2885 grm.	0·1707 grm.	0·6732 grm.	60·225
1·4090 ,,	0·1857 ,,	0·7372 ,,	60·263

Mean 60·244 ± 0·012

The ceroso-ceric oxide in this case was perfectly white.

The cerium oxalate which yielded it was precipitated boiling by a boiling concentrated solution of oxalic acid. The precipitate stood 24 hours before filtering.

We may now combine the results of Wolf and of Wing as follows. The two concordant experiments of Wolf's series three and four may be united, giving a mean of 60·267 ± 0·001:—

Wolf, 1st series	60·494 ±	0·024
,, 2nd ,, ...	60·302	0·004
,, 3rd and fourth series ..	60·267	0·001
Wing	60·244	0·012
General mean ..	60·271	0·001

This mean, the percentage of CeO_2 in the anhydrous sulphate, gives Ce = 137·724; or, if O = 16, Ce = 138·039. This varies widely from the ordinarily accepted value as determined by Buehrig.

In 1875 Buehrig's† paper upon the atomic weight of cerium was issued. He first studied the sulphate, which after eight crystallisations still retained traces of free sulphuric acid. He found furthermore that the salt obstinately retained traces of water, which could not be wholly expelled by heat without partial decomposition of the material. These sources of error probably affect all the previously cited series of experiments; although, in the case of Wolf's work, it is doubtful whether they could have influenced the atomic weight of cerium by more than one or two tenths of a unit. Buehrig also found, as Marignac had earlier shown, that upon precipitation of cerium sulphate with barium chloride the barium sulphate invariably carried down traces of cerium. Furthermore, the ceroso-ceric oxide from the filtrate always contained

* *Ann. Chem. Pharm.*, 87, 12.
† *Ibid.*, 105, 45.
‡ *Poggend. Annal.*, 55, 65; 108, 44.
‖ *Amer. Journ. Science and Arts*, (2), 46, 53.

* *Am. Journ Sci.*, (2), 49, 358. 1870
† *Journ. f. Prakt. Chem.*, 120, 222.

barium. For these reasons the sulphate was abandoned, and the atomic weight determinations of Buehrig were made with air-dried oxalate. This salt was placed in a series of platinum boats in a combustion tube behind copper oxide. It was then burned in a stream of pure, dry oxygen, aad the carbonic acid and water were collected after the usual method. Ten experiments were made; in all of them the above named products were estimated, and in five analyses the resulting ceroso-ceric oxide was also weighed. By deducting the water found from the weight of the air-dried oxalate, the weight of the anhydrous oxalate is obtained, and the percentages of its constituents are easily determined. In weighing, the articles weighed were always counterpoised with similar materials. The following weights were found:—

Oxalate.	Water.	CO_2.	CeO_2.
9·8541 grms.	2·1987 grms.	3·6942 grms.	—
9·5368 ,,	2·1269 ,,	3·5752 ,,	—
9·2956 ,,	2·0735 ,,	3·4845 ,,	—
10·0495 ,,	2·2364 ,,	3·7704 ,,	—
10·8249 ,,	2·4145 ,,	4·0586 ,,	—
9·3679 ,,	2·0907 ,,	3·5118 ,,	4·6150 grms.
9·7646 ,,	2·1769 ,,	3·6616 ,,	4·8133 ,,
9·9026 ,,	2·2073 ,,	3·7139 ,,	4·8824 ,,
9·9376 ,,	2·2170 ,,	3·7251 ,,	4·8971 ,,
9·5324 ,,	2·1267 ,,	3·5735 ,,	4·6974 ,,

These figures give us the following percentages for CO_2 and CeO_2 in the anhydrous oxalate:—

CO_2.	CeO_2.
48·256	—
48·249	—
48·248	—
48·257	—
48·257	—
48·258	63·417
48·257	63·436
48·262	63·446
48·249	63·429
48·253	63·430
Mean 48·2546 ± 0·001	63·4316 ± 0·0032

From percentage CO_2 .. Ce = 141·228 ± 0·025
,, CeO_2 .. ,, 141·141 0·020

Obviously the single oxalate experiments of Jegel and of Rammelsberg would exert no appreciable influence upon these mean results. They may therefore be ignored.

In combining all of these data in one general mean, we may begin as usual by tabulating our ratios:

(1). $BaSO_4 : Ce_2(SO_4)_3$: : 100 : 123·019 ± 0·113
(2). $BaSO_4 : CeO_2$: : 100 : 49·360 ± 0·035
(3). $BaCl_2 : Ce_2(SO_4)_3$: : 100 : 91·625 ± 0·016
(4). $AgCl : CeO_2$: : 100 : 40·469 ± 0·0415
(5). P.c. CeO_2 from anhydrous sulphate, 60·271 ± 0·001
(6). ,, ,, ,, oxalate, 63·4316 ± 0·0032
(7). ,, CO_2 ,, ,, 48·2546 ± 0·001

These ratios give us four values for the molecular weight of CeO_2 and two values for $Ce_2(SO_4)_3$:—

From (2)	CeO_2 = 172·218	± 0·124
,, (4)	,, 173·663	0·179
,, (5)	,, 169·651	0·034
,, (6)	,, 173·068	0·033
General mean ..	,, 171·490	0·023
From (1)	$Ce_2(SO_4)_3$ = 567·234	± 0·522
,, (3)	,, 570·375	0·165
General mean ..	,, 570·093	0·156

Hence we have three independent values for the atomic weight of cerium, as follows:—

From molecular weight of CeO ..	Ce = 139·563	± 0·024
,, ,, $Ce_2(SO_4)_3$	,, 141·281	0·083
From ratio (7) CO_2 in oxalate.. ..	,, 141·228	0·025
General mean ..	140·424	0·017

Or, if O = 16, Ce = 140·747.

Buehrig's results alone, both sets combined, give Ce = 141·198 ± 0·020; or, if O = 16, Ce = 141·523.

Wolf and Wing's figures alone make Ce = 137·724; or, if O = 16, Ce = 138·039.

The latter result is subject to the errors pointed out by Buehrig as involved in the use of cerium sulphate; but the ceroso-ceric oxide obtained in the analyses was pure white. Buehrig's ceroso-ceric oxide, on the other hand, was yellow. In neither case was didymium present. All things considered, therefore, it is probable that the lower result is too low and the higher result too high. How near the general mean of all may be to the truth we have no evidence to show. It is clear that new determinations are needed, made with material yielding *white* ceroso-ceric oxide, and with avoidance of the sources of error which Buehrig pointed out.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, June 19, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificate was read for the first time:—L. Ehrmann.

During the evening a ballot was held, and the Scrutators (Drs. Plimpton and Miller) declared the following gentlemen duly elected:—W. Alabaster, H. B. Baker, W. T. Burgess, E. G. B. Barlow, R. D. Courtney, E. J. Caley, M. H. Foye, W. F. Fremersdorff, W. F. Grace, J. Hargreaves, Baron F. von Mueller, E. L. C. Muspratt, F. Nettlefold, A. G. Page, J. Parr, E. H. Rogers, R. S. Stephens, T. Stormouth, R. C. Tresidder, A. J. Watts, J. S. Wells.

Dr. GLADSTONE then took the chair while the PRESIDENT communicated the substance of a most important and lengthy paper entitled "*On the Magnetic Rotary Polarisation of Chemical Compounds in Relation to their Composition; with observations on the Preparation and Densities of the Bodies Examined,*" by W. H. PERKIN, F.R.S. In a preliminary note on this subject, read before the Society about two years ago, it was shown that no definite laws could be expected by the ordinary system of comparing the rotary effect of unit lengths of fluid, and that a comparison of molecular lengths (*i.e.*, such lengths of fluid that the ray of light in passing through them should in all cases traverse the same number of molecules) must be made if any relationship in the rotary effect of various bodies was to become apparent. It was further shown that the rotation due to these molecular lengths may be calculated from observations made on unit lengths by the formula $\frac{r.Mw}{d}$; where r = rotation observed: Mw the molecular weight, and d the density; and that if this number be divided by the number similarly obtained for the standard of comparison (in this case water), the result will be *the molecular coefficient of magnetic rotation*, or, more briefly, the *molecular rotation*. Examples were then given, calculated from original observation as well as from numbers taken from the papers of Becquerel and De la Rive, fully confirming this view, and plainly showing the existence of definite laws governing the magnetic rotary polarisation. These investigations have been continued, and the present communication embodies the results of the careful obser-

vations of about 140 substances belonging to the various classes of the fatty series of organic compounds. From these results it is clear that in a strictly homologous series the introduction of each CH_2 is marked by an increase in the molecular rotation. This constant for CH_2 was found (as the mean of a large number of closely concordant observations) to be 1·023. Each series has, in addition, its own initial or *series constant*; and it was found that when this initial constant has been once determined for a series by the careful observation of one of its members the molecular rotation of any other members may be found by the formula Mol. Rot. $= s + 1{\cdot}023.n$; where s = the initial or series constant, and n the number of carbon atoms in the molecule. It is found, however, that in speaking of homologous series the first, and in most cases the first two, members of the series must be omitted. This agrees with the results obtained by other investigators when dealing with other chemical and physical properties, and it appears as if the influence of the hydrocarbon portion of these substances was to a greater or less extent neutralised by that of the extraneous elements, and that the truly homologous series never commences until there are at least three carbon atoms in the nucleus. Again, isomerism plays an important part; and for the above law to hold good it is necessary that the series should be homologous not only in molecular weight, but also in molecular constitution. Thus, taking as the standard the line formed by the molecular rotation of a series of normal compounds, the numbers obtained for iso and secondary bodies of that series lie above the line, those for tertiary bodies being still higher. In fact, the increase of methyl groups tends to raise the molecular rotation; or, in other words, the more complicated the construction the greater the influence on polarised light. In some cases the influence of isomerism is still more marked—as, for instance, in the case of ethylene and ethylidine compounds, and, in fact, wherever there are two or more non-hydrocarbons radicals or elements present in the compound. In this case the numbers obtained vary both according to the arrangement of the carbon atoms in the nucleus, and also as to the position of the substituting radicals, whether they are on the same carbon atom, or on neighbouring or on more distant ones. This is well shown in the case of the ethers of the dibasic acids of the $C_n H_{2n-2}O_4$ series. The acids being solids could not be examined. The normal series appears here to have the formula $COOEt(CH_2)_n COOEt$, and the first member of the truly homologous series to be succinic or possibly glutaric ether. With the help of the malonic acid derivatives a considerable number of representatives of the lower members of this series were obtained and examined. The four ethers of the formula $C_3H_6(COOEt)_2$ will form good examples of the effect of molecular isomerism in this series. The molecular rotations are ethyl glutarate, 9·403 (calculated from succinate); ethyl pyro-tartrate, 9·347; ethyl ethyl-malonate, 9·272; and ethyl dimethyl-malonate, 9·268. With halogen derivatives of polyvalent radicles these isomeric variations are still more marked, the bromides being especially conspicuous in this respect. Turning to the influence of the successive replacement of hydrogen in a compound—the number of carbon atoms in the nucleus remaining unchanged—by a negative radical, it will at once be seen, from what has been said on the effect of isomerism, that it becomes much more difficult to obtain any *fixed* increment as the cases of possible isomerism are so much increased, and it becomes almost impossible to say which kind of replacement should be considered as constituting the homologous series. This difficulty is much added to by the fact that it is almost impossible to obtain these poly-substituted bodies in sufficient numbers and purity for the determinations; many of the bodies, suitable in other respects, melting at too high a temperature. The abstraction of hydrogen (*i.e.*, the rendering unsaturated) of a compound has a most marked and curious influence on its magnetic rotation, raising it about one unit above the normal line for each diminution of H_2. Thus, propyl-alcohol, 3·769; allyl-alcohol, 4·683—difference, 0·914; and ethyl-propyl-malonate, 10·367; ethyl-allyl-malonate, 11·281. Difference, 0·914. Attempts were made to calculate from the results the rotation values of the elements, but it will be seen, on consideration, that as the isomerism of the molecules plays such a leading part in the determination of molecular rotation, the value of the elements must vary according to their position in the molecule, and that the most that could be obtained would be values varying between certain limits or constants for certain series. It is believed that this variation of molecular rotation, due to molecular isomerism, may prove of great use to chemists in helping to determine the constitution of doubtful bodies. The following are the series constants obtained for a large number of different series:—Paraffins, C_nH_{2n+2}, 0·512; iso-paraffins, 0·625; alcohols, $C_nH_{2n+2}O$, 0·700; iso- and sec.- alcohols, 0·845; oxides, $C_nH_{2n+2}O$, 0·642; iso-oxides, 0·932; aldehyds, $C_nH_{2n}O$, 0·264; iso-aldehyds and ketones, 0·377; acids, $C_nH_{2n}O_2$, 0·393; iso-acids, 0·504; formic ethers, ethyl and above, 0·495; acetic ethers, ethyl and above, 0·370; acetic ethers, iso-positive radicals, 0·483; ethers, methyl, 0·273; ethers, ethyl and above, 0·336; iso-ethers, ethyl and above, 0·449; ethers, succinic series, C_nH_{2n-2}, methyl, 0·093; ethers, succinic series, ethyl, 0·196; ethers, succinic series, iso-positive radicals, 2·432; chlorides, $C_nH_{2n+1}Cl$, 1·988; iso- and sec. chlorides, 2·052; bromides, 3·814; iso- and sec. bromides, 3·902; iodides, 8·006; iso- and sec. iodides, 8·092; ethyl-ethers, oleic series, $C_nH_{2n-2}O_2$, 1·452. All the observations were made for the D line of the spectrum. A lamp was used in which hydrogen was passed over strongly-heated sodium, contained in a piece of iron gas-barrel, and thus the gas becoming impregnated with sodium vapour burnt at the nozzle and gave a very brilliant mono-chromatic flame, the size of which could be varied at pleasure. During this research a large number of careful determinations of densities of pure substances were made, and attention has already been called (Chemical News, xlix., 122), to the relationship which the densities of members of homologous series show to one another, and the curves which are formed both by the densities and co-efficients of expansion. The author exhibited the sodium lamp, the pole pieces of the magnet, the tubes, the modified Sprengel tube for taking the densities, &c.

Prof. Ayrton said that, although the paper was eminently chemical, he had, as a practical electrician, listened with much interest. It would be of great importance to determine the magnetic value of the field; it would be difficult as the field was not uniform, but it might easily be made uniform. If it were uniform its strength might be measured in terms of Verdet's constant, and we might convert Perkin's numbers into absolute measurements. This having been done the apparatus might be used to determine the strength of a current in absolute measure. It would be very portable and very convenient if a suitable liquid were chosen; so many seconds rotation of the D line would indicate so many amperes.

Dr. Glazebrook some years ago undertook some researches to determine the magneto-rotary power of solutions of certain salts. He had met with two difficulties—the want of a good sodium flame, and the fact that the differences between solutions of varyiug concentration were so small. A plan somewhat similar to that proposed by Prof. Ayrton for determining the strength of a current had been carried out by Lord Rayleigh. The results were not very satisfactory. Bisulphide of carbon was the liquid employed.

After the thanks of the meeting had been given to Dr. Perkin, the Society adjourned over the summer vacation to Nov. 6th, the following papers, in consequence of the lateness of the hour, being taken as read.

"*On the Effect of High Temperatures on Petroleum Hydrocarbons*," by Drs. Armstrong and Miller. In this paper the authors describe the results of their examination of the liquid obtained on compressing oil-gas, such as is made by passing the vapour of petroleum through

highly heated retorts ; they point out that their material is in every respect similar to that examined by Faraday in 1825, and in which he discovered benzene. Besides benzene and its homologues the liquid from oil-gas contains hydrocarbons of the ethylene and acetylene series. It is noteworthy that the latter are none of them true homologues of acetylene, as they are incapable of forming metallic compounds analogous to acetylide of copper; they are probably all derivatives of allene, $CH_2.C.CH_2$, the isomer of allylene or methyl-acetylene. From the fractions boiling below benzene, two hydrocarbons of the acetylene series have been isolated, methylallene, $CH_3.CH.C.CH_2$, identical with the crotonylene separated by Caventon from the mixture of hydrocarbons condensed by compression of coal-gas and hexoylene, C_6H_{10}, identical with that described by Schorlemmer. The crystalline tetrabromides of these hydrocarbons have both been obtained in large quantity in a pure condition. As yet it has not been found possible to isolate the intermediate hydrocarbon, C_5H_8. The fractions below benzene contain two olefines, amylene and hexylene. A study of their oxidation products shows that both of these are the normal hydrocarbons, the amylene furnishing an oxidation with permanganate, normal butyric acid, the hexylene being converted into normal valeric acid ; in other words, the amylene is normal propyl-ethylene, the hexylene normal butyl-ethylene. In conclusion it is pointed out that this is an extension of the investigation of Thorpe and Young. By heating paraffin under pressure at a comparatively moderate temperature they obtained a mixture, with corresponding olefines of lower (normal) paraffins down to pentane. At the higher temperature of the oil-gas retorts, the paraffins are completely converted into olefines, acetylenes, benzenes, &c. It is not improbable that the benzenes are products in a direct line of the action of heat on the paraffins, and that they are not built up as has been supposed from hydrocarbons of the acetylene series.

"*On the Decomposition of Terpenes by Heat*," by W. A. Tilden. The following are the conclusions arrived at by the author :—When ordinary turpentine oil is exposed to a temperature just short of redness, the greater part of it is transformed in four different ways, viz., into an optically inactive terpene, by polymerisation into a colophene, by resolution into cymene and hydrogen, by splitting up into two molecules of a pentine, C_5H_8. These are probably the immediate changes which it undergoes ; the small quantities of other hydrocarbons, which are simultaneously produced, being the result of secondary reactions. The citrenes yield the same pentine as also does terpilene, though less readily. The pentine obtained from the terpenes is identical with isoprene. This pentine is readily polymerised by heat into terpilene. From this easy transformation of $2C_5H_8$ into $C_{10}H_{16}$, and *vice versa*, it appears probable that the molecule of terpilene is composed symmetrically of two halves. The pentine from turpentine or isoprene, as it may now be called, is a lower homologue or isomeric, with a lower homologue of heptine from rosin spirit, which has been shown by Morris to be probably methyl propylallene. As the pentine is polymerisable by heat or by sulphuric acid into a dipentine, so the heptine may be converted into a diheptine. $C_{14}H_{24}$ is a liquid boiling 235° to 240°, which appears to possess all the properties of the terpenes. The author intends to examine this compound to ascertain whether it is entitled to rank as a true homologue of turpentine.

"*A Short Note on the General Law which Govern the Dilatation of Liquids*," P. de Heen.

"*On the Melting-points of Certain Inorganic Substances*," by T. Carnelly and L. T. O'Shea.

"*On Nitrification. Part* III.," by R. Warington.

Case of Isomerism in Chloronitrous Camphor.—P. Cazeneuve.—The isomer obtained is soft, not readily pulverised, and dextro-rotatory. The normal compound is hard, friable, and lævo-rotatory.—*Bull. Soc. Chim.*

NOTICES OF BOOKS.

The Non-Bacillar Nature of Abrus Poison: With Observations on its Chemical and Physiological Properties. By C. J. H. Warden, Professor of Chemistry, Calcutta Medical College, and L. A. Waddell, M.B., Resident Physician, Medical College Hospital, Calcutta. Calcutta: Bengal Secretariat Press, 1884.

The poisonous principle contained in the seeds of the Indian liquorice plant, or "jequirity," of the Brazilians, has been the subject of some amount of discussion and investigation. The nature and mode of action on the animal economy of the active agent contained in these seeds have been but imperfectly studied, although abrus seeds have been used extensively in India for many years for poisoning cattle and frequently for homicidal purposes. A remarkable point about abrus seeds is that, although they may be taken in quantity by the mouth with impunity, and indeed form an article of diet in Egypt, when a small quantity of the powdered seeds is introduced beneath the skin, fatal results ensue ; less than two grains of the powder administered in this way to cattle occasion death within 48 hours.

It has long been known that an infusion of abrus seeds excites acute inflammation of the conjunctiva, and Sattler has recently come to the conclusion that this inflammation is an infective disease produced by a bacillus present in the air,which takes on pathogenic qualities when growing in an infusion of abrus seeds. This hypothesis of Sattler's was made the starting point of an investigation by MM. Cornil and Berlioz, on the influence of the bacillus on the organism as a whole, and the startling conclusion they arrived at was that the poisonous action of abrus seeds is due to a specific bacillus—"the bacillus of jequirity,"—derived from the seeds, and developing first in the seat of the injection of the infusion, ultimately taking hold on the whole organism and causing death. M. Cornil has even been led so far by his enthusiasm as to assert as the crowning point of his observations that the subcutaneous injection of a small dose of this poison secures the individual against the effects of a further dose, as Pasteur has shown to be the case far certain forms of infective diseases.

This little pamphlet contains the results of the authors' investigations on the existence of this "bacillus of jequirity seeds," with an account of the chemical properties and physiological action of the poisonous principle contained in these seeds. The preface tells us that the presence of Dr. Koch and the German Cholera Commissioners at the Medical College Hospital enabled the authors of this pamphlet to investigate the bacterial side of the question much more completely than could otherwise have been done, the observations being conducted under the immediate superintendence of Dr. Koch. The conclusions the authors arrive at with regard to the bacterial theory of abrus poison are diametrically opposite to those of MM. Cornil and Berlioz. They found neither bacilli or their spores in the seeds, and but very few in the bodies of poisoned animals ; that the intensity of the topical action of abrus seed infusion, like that of chemical irritants, depends upon the concentration of the infusion and number of applications ; that the toxic action of unsterilised abrus infusion is not necessarily associated with a generalised bacillar formation ; when bacilli are found in the blood, their presence is purely accidental and they are non-pathogenous and non-specific ; that the blood of an animal killed by abrus poison is not infective, and that a small dose does not confer immunity against further innoculation.

The chemical examination of abrus seeds did not reveal the presence either of an alkaloid or glucoside ; the crystalline acid extracted, named abric acid, was proved conclusively to be practically an inert body. The aqueous extract, heated to the boiling-point, was found to have lost

all its poisonous character, although the dried seeds could be kept at 100° for some time without losing materially their activity. The poisonous principle, called abrin, was extracted by percolating the bruised seeds with cold water and precipitating with alcohol, the fatty and colouring matters being first removed by chloroform and dilute alcohol. From their chemical examination of abrin the authors conclude that it is an albumin, as its composition approximates that of egg and some of the vegetable albumins.

The mode of action of abrin was investigated, but the results obtained still leave the matter in doubt. Although experinents showed that abrin does not possess any of the characteristic properties of the soluble ferments, the authors consider there is some analogy between it and snake poison.

To this interesting toxicological pamphlet a number of appendices are added relating to the botanical characters of *Abrus precatorius*, the therapeutic use of abrus seeds in ophthalmia, and an account of the manner in which the natives of India prepare and employ the seeds in the form of needles called "suis" or "sutaris," for poisoning cattle.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 21, May 26, 1884.

Electric Conductivity of Anhydrous Salts, Liquid and Solid.—M. Fousserau.—The author gives his results in the form of tables. He finds that melted salts are in general better conductors than cold saline solutions. The ratio of the coefficient of friction to the resistance remains constant for each salt.

Thermic Study of the Alkaline Fluo-silicates.—Ch. Truchot.—This memoir is not capable of useful abridgment.

Researches on the Bromised Phenols.—E. Werner.—A thermo-chemical paper. The author has determined the melting heat, the specific heat, and the neutralisation heat of these compounds.

Certain Reactions of Albumen.—E. Grimaux.—Albumen in dilute solution is converted by the action of heat into a body which possesses the properties of the albuminates, closely bordering upon those of caseine. If solutions of albumen containing 1 per cent of dry matter are heated to 90° for some minutes a few flocculi separate, but the clear filtrate does not become turbid on boiling; but by the action of carbonic acid in the cold it gives a gelatinous precipitate, which re-dissolves in a current of air.

Analysis of Arable Soils.—G. Lechartier.—M. Grandeau has shown that oxalic acid destroys the calcareous compounds into which the humic matter of the soil enters. The author therefore thought that ammonium oxalate should dissolve not merely the humic compounds, but the mineral principles which are most readily dissolved and assimilated. This expectation has been verified experimentally. The author introduces into a litre flask 20 grms. of the dried soil, previously ground up with a wooden pestle, and 250 c.c. of a solution containing 10 grms. ammonium oxalate, with an excess of ammonia. To the neck of the flask is fitted an ascending refrigerator, and the liquid is heated to a boil. At the outset there is a tendency to swell up, but the ebullition soon becomes regular, and can be kept up without difficulty for seven to eight hours. The brown solution is filtered off and evaporated to dryness. The ammoniacal salt and the dissolved organic matters are decomposed by heat, and there remains a reddish residue, which is treated with hydrochloric acid. In the solution we determine successively the phosphoric acid, the oxides of iron and aluminium, the lime, magnesia, and potash. To exhaust the action of the ammoniacal salt upon the soil a second operation is necessary. The filter with the undissolved portion of soil is reintroduced into the flask and again treated as above.

Bulletin de la Société Chimique de Paris.
No. 6, March 20, 1884.

Thermic Study of Certain Mercury Oxy-chlorides and Oxy-bromides.—M. G. André.—The formation-heat of the oxy-chlorides increases progressively by about 1 cal., as the basicity of the compound increases by 1 mol. HgO, whether the body has been prepared by the dry or the moist method. The formation-heats of the oxy-bromides are a little smaller than those of the corresponding lead compounds, and likewise than those of the mercury oxy-chlorides of the same formula.

Tetranitrous Ethylene Bromide.—A. Villiers.—A further account of the reactions of this body.

Nitro-derivatives of Ethylene Hydride.—A. Villiers.—The author has studied the reduction derivatives of the potassium compound of tetranitric ethylene bromide. He has examined the results of the reaction of sulphurous acid, sodium amalgam, and zinc, in an alkaline solution, which effect a complete reduction with the formation of ammonia and hydrobromic and hydrocyanic acids. With ammonium hydrosulphate several compounds are obtained, the examination of which is still incomplete.

Bromo Xylenol.—P. Adam.—The author sets out with paraxylenol, which is readily bromised by heating to 160°, withdrawing it from the bath and adding the bromine rapidly.

Reply to the New Reclamation of M. Sestini.—MM. C. Vincent and Delachanal.—A dispute concerning priority in a process for the manufacture of potassium sulpho-carbonate.

Synthesis of Tartaric Glucoside.—Antony Guyard.—The author has obtained this compound by throwing tartaric anhydride in fine power powder into melted glucose until the mixture becomes pasty.

Oxidation and the Determination of Chromium Sesquioxide.—H. Baubigny.—This memoir will be inserted at considerable length.

Action of Chlorine upon the Sulphonic Compounds and upon the Amylic Oxy-chlorides.—W. Spring and C. Winssinger.—Not capable of useful abstraction.

No. 7, April 5, 1884.

Action of Methylene Chloride upon Toluene and Benzine.—C. Friedel and J. M. Crafts.—The authors on treating toluene with methylene chloride in presence of aluminium chloride in a reflux apparatus, obtained at the temperature of 290° a considerable quantity of ditolylmethane, and then, at a higher temperature, a crystalline hydrocarbon, having the same fusion-point as dimethylanthracene. There are also formed, in small quantity, carbides which boil at a higher temperature than xylene, and which seem to be trimethyl-benzols. They have repeated the same experiment with benzine, and have obtained dimethyl-methane and anthracen.

Two Camphol-urethanes of a Physical Isomerism analogous to that of Dextro- and Lævo-tartaric Acids.—A. Haller.—The author gives crystallographic measurements proving that the crystals of lævo-camphol-urethane are the inverse analogues of the corresponding dextro-compound.

Ethyl- and Methyl- Acetyl-cyan-acetate of Ethyl.—A. Held.—The ethyl compound is a colourless liquid, of sp. gr., 0·976 at + 20°, becoming yellowish in a few days,

soluble in alcohol and ether in all proportions, but insoluble in water and in alkaline solutions, a property which distinguishes it from acetyl-cyan-acetic ether. The methyl compound has the spec. gr., 0·996 at + 20°, boils at 90° to 95°, and is also insoluble in water and alkalies.

The Oxidation of Menthol by means of Potassium Permanganate.—G. Arth.—The author obtains a compound, $C_{10}H_{18}O_3$, of an acid character.

A New Reaction of Ethyl Carbamate.—G. Arth.—The author treats ethyl carbamate with an alcoholic solution of potassa. After boiling for a half an hour with a reflux condenser he obtains hard, brilliant, lamellar crystals. A solution of this body evaporated with ammonium sulphate yields urea.

Alkali Manufacture.—G. Scheurer-Kestner.—An account of the two forms of Gay-Lussite (an insoluble compound of lime and soda) formed under different circumstances and containing different proportions of water.

The Action of Air on Solutions of Tannin, and the Determination of Tannins.—Antony Guyard.—This paper will be inserted in full.

The Determination of Ammoniacal Nitrogen in Soils.—Antony Guyard.—The author recommends that in the analysis of a soil there should be stated the ammoniacal nitrogen, as obtained by means of calcium carbonate; the organic nitrogen very easily convertible into ammonia, as found by means of basis magnesium carbonate; the nitrogen easily convertible into ammonia by means of calcined magnesia; the nitrogen convertible into ammonia by means of quick-lime; a second portion of nitrogen convertible into ammonia by using 0·5 to 1 grm. soda to 100 parts of soil, and finally the total organic nitrogen as obtained by combustion with soda-lime.

The Separation and Determination of Lime in Presence of a large excess of Alumina, Magnesia, Ferric Oxide, and Phosphoric Acid.—A. Guyard.—Already inserted.

Russian Chemical Society.—Session, September 15/27, 1883.—M. Solovieff sent in a calculation of the number of the normal saturated hydrocarbons.

M. Sokoloff communicated the results of an analysis of the waters of the Neva during the month of September.

M. Konovaloff read a paper on the thermic effect produced by the mixture of liquids.

M. Alexeef gave some instances of the solutions of two liquids in which the thermic effect may be explained by the change in specific heat.

Part 7 of the 15th volume of the *Journal of the Russian Chemical Society* contains memoirs on pyrosulphuryl chloride, by M. Konovaloff; on the relation between the specific refractive energy of chemical compounds and their composition, by M. Kanonikoff; on the velocities of chemical reactions, by M. Potilitzine; and on the present state of the theory of explosives, by M. Tchelzoff.

Justus Liebig's Annalen der Chemie,
Vol. 222, Part 2.

Contributions to our Knowledge of Molybdenum and Tungsten.—Baron Otto von der Pfordten.—The analytical methods contained in this important paper will be given in full at an early opportunity.

Substituted Benzoic Acids and the Nature of the Hydrogen Atoms in Benzol.—H. Hübner.—Part II. This memoir gives an account of meta-brom-meta-nitro-benzoic acid and its derivatives; of para-brom-benzoic acid, para-chlor-benzoic acid, and their derivatives; and of ortho-chlor-benzoic acid.

Studies on Morphine.—O. Hesse.—The author has investigated the behaviour of morphine with acetic anhydride, propionic anhydride, and methyl iodide; the behaviour of the morphine-methyl compounds with acetic anhydride; the action of methyl iodide upon morphine in presence of bases; the behaviour of methyl morphine (codeine) with acetic and propionic anhydride; the action of methyl iodide upon methyl-morphine; the behaviour of methyl-morphine-methyl-chloride with acetic anhydride; the reaction of the corresponding iodide with bases and of the hydroxide concerned with water; the behaviour of methyl-morphimetine with acetic anhydride and methyl iodide; the action of acetic anhydride upon the α-chloride; the behaviour of the α-iodide with alkali, and the reaction of the β-chloride with acetic anhydride. The author concludes from the results obtained that morphine contains only two atoms of hydrogen, capable of being substituted by radicles of the fatty series. One of the hydroxyles in morphine is more resistant than the other.

On Pseudomorphine.—O. Hesse.—The author proves that both the oxymorphine of Schützenberger and Nadler's alleged new base obtained by the action of cupric oxide-ammonium upon morphine are both simply pseudomorphine. He describes a number of the salts of pseudomorphine and gives an account of the behaviour of this base with acetic anhydride.

Cosmos les Mondes.
No. 17, April 26, 1884.

This number contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Prussian Blue.—(Reply to P. B.)—For an outlet for Prussian blue in quantity, I would say that there is a large amount used in the United States for making barrel paint to be used in oil refineries. In fact, I think the chances in that direction are better than any other. —Oil Merchant, Cincinnati, O., U.S.A.

TO CORRESPONDENTS.

H. R.—Oxygen is returned to the atmosphere through the influence of vegetation.

AMMONIACAL LIQUOR.

THE DIRECTORS OF
THE COMMERCIAL GAS COMPANY
are prepared to receive Tenders for the Ammoniacal Liquor produced at their several Works for the Eighteen Months ending June 30, 1886.

The quantities of Coal Carbonised are estimated to be as under, but the same cannot be guaranteed, and may be more or less:—

At the Stepney Works, in the Regent's Canal, about 80,300 tons per annum.

At the Wapping Works, in the Thames, about 33,500 tons per annum.

At the Poplar Works, in Bow Creek (free water-way), about 53,000 tons per annum.

The Tenders may be for the whole, or for one or more Works separately.

The Contractors must give security to remove the Liquor as it accumulates, to pay for the same monthly, and generally for the due fulfilment of the contract.

The form of agreement to be signed can be seen at the Company's Offices on application to the Engineer.

Tenders, sealed, and endorsed "Tender for Ammoniacal Liquor," to be delivered here not later than the 3rd of July next.

The Directors reserve to themselves the right to accept any Tender in part or in whole, and do not bind themselves to accept the highest or any Tender.

By Order of the Board,
H. D. ELLIS, Secretary.

Commercial Gas Works,
Stepney, E.
May, 1884.

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THE CHEMICAL NEWS.

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No. 1284.—JULY 4, 1884.

ON THE REVERSION OF PHOSPHORIC ACID.

By THOMAS S. GLADDING, A.M.

In a previous paper,* the writer has demonstrated among minor considerations the following points:—

I. That reverted phosphoric acid exists in three forms in commercial superphosphates:

(*a*) As reverted phosphate of lime,
(*b*) ,, ,, ,, iron,
(*c*) ,, ,, ,, alumina.

II. That artificially-precipitated phosphate of lime, whether the di-calcic or tri-calcic form, when mixed with sulphate of lime (as is the case in a superphosphate), and exposed to atmospheric conditions in shade in open vessels for several days, and dried to a pulverulent powder, is readily and completely soluble in a neutral solution of citrate of ammonia, at the temp. of 40° C.

III. That artificially-precipitated phosphates of iron and alumina, when treated in the same way, become largely insoluble in the citrate of ammonia solution, at the temp. of 40° C.

IV. That a citrate of ammonia solution alone, of all the solvents that have been proposed, is a perfect solvent for all the forms of reverted phosphates (as they exist in superphosphates), while at the same time it does not unduly dissolve the crude or insoluble phosphate present.

V. Lastly, and most important of all, the citrate of ammonia solution, in order to be a perfect solvent for reverted phosphates of iron and alumina, as they exist in commercial superphosphates, must be used at a temp. of 65° C. (150° F.). At this temp. every form of reverted phosphate is dissolved.

In the present publication, the above points are more fully sustained by additional experiments, and the investigation has been extended to a consideration of the reversion of soluble phosphates in artificial and natural soils.

The inquiry may be divided for the sake of clearness into the following heads:—

I. Experiments on natural phosphates,
II. ,, ,, artificial soils,
III. ,, ,, natural ,,

I. *Experiments on Natural Phosphates.*

To make the investigation on this point as conclusive as possible, a very large number of natural phosphates, embracing nearly every commercial article, was collected.† These samples were all ground to pass through a 60-mesh sieve, no further grinding nor trituration being employed. Several litres of a neutral citrate of ammonia solution, sp. gr. 1·09, were prepared. 1 grm. of each phosphate was accurately weighed, and washed into a 200-c.c. flask with 50 c.c. of the above solution. The flask was corked and the contents digested for thirty minutes as follows:—

1st. 1 grm. with neutral solution at temp. of 40° C.
2nd. ,, ,, ,, ,, ,, 65 ,,
3rd. ,, ,, ammoniacal ,, ,, ,, ,,
4th. ,, stronger ,, ,, ,, ,, ,,
5th. ,, with acid ,, ,, ,, ,,

In digestion 3rd, ½ c.c. of 20 per cent ammonia solution was added to every 50 c.c. solution of citrate of ammonia.

In digestion 4th, 1 c.c. of 20 per cent ammonia solution was added to every 50 c.c. of citrate of ammonia solution.

In digestion 5th, 0·753 grm. of citric acid were added to every 50 c.c. of citrate of ammonia solution; this quantity is just equivalent to 0·200 grm. of ammonia, the amount of free ammonia added to every 50 c.c. in digestion 4th.

Besides the general interest which attaches to the table (see next page), as showing the relative solubility of the different natural phosphates when treated exactly alike with citrate of ammonia solution, the following points are worthy of consideration:—

1. A slight acidity of the solution largely increases the quantity of raw phosphate dissolved, as is shown by average (3).

2. A slight alkalinity *decreases*, to a marked extent, the solvent action on all *phosphates of lime*, as is shown by averages (1) and (2).

3. A stronger alkalinity decreases still more this solvent action on phosphates of lime, as is shown by average (3).

4. An alkalinity *increases*, on the other hand, the solvent power of the citrate of ammonia solution on phosphates, when the phosphoric acid exists as *phosphates of iron and alumina* and not as phosphate of lime, as is shown by average (4).

As the aim of the ideal method of determining reverted phosphoric acid is to separate the precipitated phosphates from the original insoluble phosphate still left in a fertiliser, it follows from the above four points that the *neutral* citrate of ammonia solution is decidedly superior to either an acid or ammoniacal solution.

5. A change in the temperature of digestion, from 40° C. to 65° C., increases only slightly the solvent action on natural phosphates, as is shown by average (1); the increase being from 2·91 per cent to 3·17 per cent, a difference of only 0·26 per cent.

* *Amer. Chem. Journ.*, vol. iv., No. 2; CHEMICAL NEWS, vol. xlvi., pp. 18, 21.

† For many of the samples used, thanks are due to Dr. C. U. Shepard, junr.

No.	Commercial Name.	Digestion 1st. With neutral citrate of ammonia solut'n. Temperature 40° C.	Digestion 2nd. With neutral citrate of ammonia solut'n. Temperature 65° C.	Digestion 3rd. With neutral cifrate of ammonia solut'n., with 1·2 c.c. ammon. added to each 50 c.c. Temp. 65° C.	Digestion 4th. Witn neutral citrate of ammonia solut'n., with 1 c.c. ammonia added to each 50 c.c. Temp. 65° C.	Digestion 5th. With neutral citrate of ammonia solut'n., with 753 g. citric acid added to each 50 c.c. Temp. 65° C.
		Per cent Phosphoric Acid Dissolved.				
	Lime Phosphates.					
1.	Apatite (Canadian)	0·30	0·56	0·39		
2.	Caceres (Spain)	0·41	0·38	0·47		
3.	Cambridgeshire Cops.	0·56	0·85	0·44		
4.	Logrosan	0·68	0·41	0·66		
5.	Oruba	1·22	2·09	1·14		
6.	Curacao	1·28	1·35	0·95		
7.	Bedfordshire Cops.	1·38	1·18	0·95		
8.	Fr. Phosphorite, Dept. Lot	1·64	1·88	1·50		
9.	„ „ Dpt. Lot-et-Gar.	1·88	1·90	1·59		
10.	Sombrero	1·84	2·29	2·00		
11.	Avalo (fine)	1·96	2·12	1·82		
12.	Orchilla	4·63	4·81	3·67		
13.	Bone-black	5·47	6·13	4·00		
14.	Avalo (lump)	5·60	5·83	4·48		
15.	Raza Island (Gulf of California)	5·92	6·17	5·71		
16.	Lahn Phosphorite	0·82	0·76	1·35		1·59
17.	Suffolk Cops.	2·83	2·73	2·05		5·00
18.	Bone-ash	2·97	3·93	2·61		5·71
19.	Mona Island	6·47	6·82	5·91		9·31
20.	Peruvian Guano (Tarapaca)	12·74	13·14	11·99	8·98	16·17
21.	South Carolina (river)	1·09	1·35	1·06	1·06	2·89
22.	Navassa	2·73	2·53	1·86	1·22	4·87
23.	Curacao Guano	6·00	6·19	4·59	3·86	
	Average (No. 1)	2·91	3·17	2·76		
	Average (No. 2) (20—23 incl.)		5·80	4·85	3·78	
	Average (No. 3) (16—22 incl.)		4·46			6·50
	Iron and Alumina Phosphates.					
24.	Grand Connetable	1·16	1·97	5·82	11·44	1·12
25.	El Roque	1·36	1·96	4·27	5·68	
	Average (No. 4)	1·26	1·96	5·04	8·56	1·12

II. *Experiments on Artificial Soils.*

In these experiments, finely-ground sand was used to represent the soil mass.

With weighed and separate portions of this were mixed weighed quantities of—

(1) Carbonate of lime, freshly precipitated.
(2) Oxide of iron „ „
(3) „ aluminum „ „
(4) *Brown hematite, finely ground.
(5) †Bauxite „ „

Experiment 1.

(*a*) To a mixture of 5 grms. fine sand with 0·250 grm. of carbonate of lime, was added 0·200 grm. sodium ammonium phosphate dissolved in water. After exposure in an open vessel, in the shade, for seventy-two hours, it was divided into two equal parts and digested in neutral ammonium citrate solution thirty minutes, with following results :—

Temp. 40° C. Phos. acid dis. 0·0767 grm.
Temp. 65° C. Phos. acid dis. 0·0761 grm.

showing that the reverted phosphate was completely dissolved at both temperatures.

(*b*) Mixture 5 grms. fine sand, 0·500 grm. ppt. carbonate of lime with solution of 0·500 grm. sodium ammonium phosphate, was exposed in an open vessel in the sun, seventy-two hours. After drying in this manner, it was digested with citrate of ammonia solution at temp. 40° C., and all the reverted phosphoric acid was dissolved.

(*c*) A similar mixture, treated in the same manner except that it was exposed in the shade, gave the same results.

Experiment 2.

Conducted in the same manner as Experiment 1 (*a*).

Mixture 5 grms. fine sand, 1 grm. freshly-precipitated sesquioxide of iron, solution 0·500 grm. sodium ammonium phosphate containing about 0·190 grm. phosphoric acid. (There was no lime present.)

One-half digested with citrate of ammonia ; temp. 40° C.—

Phos. acid added .. .. .. 0·095 grm.
Reverted phos. acid dissolved 0·0653 „

One-half digested with citrate of ammonia ; temp. 65° C.—

Phos. acid added .. .. .. 0·095 grm.
Reverted phos. acid dissolved.. 0·096 „

Amount of reverted phos. acid not dissolved at 40° C., 0·0297 grm.

The mixture was tested for soluble, and only a trace found.

Experiment 3.

Conducted in the same manner as Experiments 1 and 2.

Mixture 5 grms. fine sand, 1 grm. freshly-precipitated hydrate of alumina, with solution of 0·500 grm. sodium ammonium phosphate, containing about 0·190 grm. phos. acid. After seventy-two hours :

One-half digested with citrate of ammonia ; temp. 40° C.—

Phos. acid added .. .. .. 0·095 grm.
Reverted phos. acid dissolved 0·0535 „

* Brown hematite, comp. $H_2Fe_2O_6$=sesquioxide iron 85·6 per cent. water 14·4 „

† Bauxite, comp. perhaps $Al(Fe)O_3+2$ aq.—*Dana.*

One-half digested with citrate of ammonia; temp. 65° C.—

Phos. acid added	0·095 grm.
Reverted phos. acid dissolved	0·0943 „

Amount of reverted phos. acid not dissolved at 40° C., 0·0415 grm.

The mixture was tested for soluble, *and only a trace found.*

Experiment 4.

Conducted in the same manner as Experiments 1, 2, and 3.

Mixture 30 grms. fine sand, 3 grms. brown hematite, with solution of 0·750 grm. sodium ammonium phosphate, containing about 0·261 grm. phos. acid.

After seventy-two hours, divided into three equal parts:—

One-third digested with cold water—

Phos. acid present	0·091 grm.
„ „ dissolved	0·0257 „
„ „ reverted..	0·0653 „

One-third digested with citrate of ammonia; temp. 40° C.—

Phos. acid present	0·091 grm.
„ „ dissolved	0·076 „
Reverted phos. acid dissolved	0·0503 „

One-third digested with citrate of ammonia; temp. 65° C.

Phos. acid present	0·091 grm.
„ „ dissolved	0·089 „
Reverted phos. acid dissolved	0·0633 „

Total reverted phos. acid present .. 0·0653 grm.
Amount „ „ „ „ not dissolved at 40° C. .. .. 0·015 „

Experiment 5.

Conducted in same manner as Experiments 1, 2, 3, and 4.

Mixture 30 grms. fine sand, 3 grms. bauxite, with solution of 0·750 grm. sodium ammonium phosphate, containing about 0·261 grm. phos. acid.

After seventy-two hours, divided into three equal parts:—

One-third digested with cold water—

Phos. acid present	0·091 grm.
„ „ dissolved	0·0344 „
„ „ reverted..	0·0566 „

One-third digested with citrate of ammonia; temp. 65° C.—

Phos. acid present	0·091 grm.
„ „ dissolved	0·0915 „
Reverted phos. acid dissolved	0·0571 „

One-third digested with citrate of ammonia; temp. 40° C.—

Phos. acid present	0·091 grm.
„ „ dissolved	0·080 „
Reverted phos. acid dissolved	0·0457 „

Total reverted phos. acid present .. 0·0566 grm.
Amount „ „ „ „ not dissolved at 40° C. .. .. 0·0109 „

Experiment 1 (*a*, *b*, *c*) shows that ammonium citrate solution at 40° C. dissolved all the reverted phosphate of lime.

Experiment 2 shows that, at temperature of 65° C., ammonium citrate solution dissolved all the reverted phosphate of iron present, while at temperature of 40° C. it failed to dissolve 31·26 per cent of the phos. acid actually reverted.

Experiment 3 shows that, at temperature of 65° C., ammonium citrate solution dissolved all the reverted phosphate of alumina present, while at temperature of 40° C. it failed to dissolve 43·68 per cent of the phos. acid actually reverted.

Experiment 4 shows that, at temperature of 65° C., ammonium citrate solution dissolved all the reverted phosphate present, while at temperature of 40° C. it failed to dissolve 22·68 per cent of the phos. acid actually reverted.

Experiment 5 shows that, at temperature of 65° C., ammonium citrate solution dissolved all the reverted phosphate present, while at temperature of 40° C., it failed to dissolve 17·49 per cent of the phos. acid actually reverted.

(To be continued.)

ON ALKALI-PROOF VESSELS.

By PROF. DITTMAR, F.R.S.

Preparative or analytical operations with caustic alkalies are beset with characteristic difficulties, which, although in a given case they may be of a purely financial nature, are none the less keenly felt. In the course of my laboratory practice I have made repeated attempts to turn these difficulties, and as one result, I have come, since about two years, to use basins of malleable nickel for operations with aqueous caustic alkalies. Nickel, until lately, was known in commerce only in the form of those "nickel-cubes" which, although they might contain as much as 99·5 per cent of the pure metal, were always utterly devoid of plasticity: they broke under the hammer. That this brittleness is not an inherent property of the metal had long been proved by A. Richter, who, in an early decade of this century had obtained the metal in a form in which it was highly malleable and ductile. Yet malleable nickel remained unknown to the arts until Fleitmann, in 1879, made a remarkable discovery. Finding that even the purest nickel which he was able to produce in his works yielded unworkable ingots, he suspected that the brittleness of the metal was owing to the presence in it of occluded carbonic oxide. He accordingly tried the effect of fusing it up with a small proportion of magnesium, and found that as little as one-eighth per cent of this addition cured the defect, and imparted to the regulus such a high degree of plasticity that it could be rolled into the thinnest sheet and drawn into very fine wire. He also found that nickel at a red heat can be welded together with iron or steel, and that a compound plate thus produced stands rolling out to any extent without breach of continuity. Since this discovery Mr. Fleitmann's firm have made a business of the production of kitchen utensils, which are nickel inside and outside, with a core of iron between the two. These utensils, as you see by the specimen I exhibit, are almost as pretty as silver ones, and practically as little given to spontaneous oxidation as these. Over copper vessels they offer the advantages of being harder and absolutely innocuous. When I read Dr. Fleitmann's publication it at once struck me that basins made of malleable nickel would be the very thing for operations with caustic alkali leys, and I caused a Glasgow silversmith to procure a supply of Fleitmann's metal and try to make it into a basin for me. My friend was not successful; the metal, although malleable at first, became stiff and intractable under the hammer. A few years later, when the idea again turned up in my mind, I applied to Messrs. Johnson, Matthey, and Company, of London, and they, after one or two failures, succeeded in producing this little basin (exhibited), which since has been used by my students hundreds of times, chiefly for the separation of iron and alumina. The basin, as I hardly need say, was not always very tenderly handled, and yet, as you see, it has quite retain its original shape, and almost its original polish. This large basin (pointing to another exhibit), which boils a litre of liquid, was procured from the same firm about eight months ago. It looks as if it came straight out of the workshop, although it has been used many a time for preparative purposes. The metal of these basins, in regard to its power of resisting the action of

caustic-alkali ley, is quite at a par with platinum; and it is certainly more convenient (apart from its being far cheaper) than silver; it has a greater permanence of form is quite devoid of porosity (which fine silver is not), and does not conduct heat so inconveniently well. A nickel basin half full of boiling caustic potash ley can be handled with the naked fingers with impunity. In the present connection the only inconvenience of these nickel vessels is that, for instance, a patch of oxide of iron which may stick to the basin must be removed mechanically, because the metal is attacked by aqueous acids, although it is dissolved far more slowly than iron is. It must also be stated that nickel basins do not stand ammonia, in the presence of air at least. That nickel basins would be proof against *fused* caustic alkali I never expected, but I was curious to ascertain what strength a caustic alkali ley must have attained before it begins to attack the metal. A solution of commercial caustic potash, containing 44 per cent of real KHO was kept in a nickel basin over a hot water-bath for over two hours, and then allowed to stand in the basin cold over night. From the loss of weight which the solution had suffered by evaporation, the finally present percentage of pure KHO was calculated to be = 59·6. Yet the basin had remained bright, and lost only 2 milligrms. of its weight. A second experiment was made with a stronger solution of caustic potash, which was kept in gentle ebullition by means of a gas lamp, the water lost by evaporation being replaced from time to time, judging by the eye. Time of exposure, this time, about one hour; original strength = 58·8 per cent of pure KHO; final strength (contrary to intention) greater, namely, = 68·6 per cent. The basin had loss 10 milligrms., from an exposed area of about 90 square centimetres, and the ley contained a trace of dissolved nickel. The limit of safety seems to lie somewhere near 60 per cent of real KHO. This second experiment was repeated with a caustic soda (instead of a potash) ley. The concentration rose from 58·5 per cent to (finally) 61·5 per cent of real NaHO. The basin was slightly but perceptibly attacked; it had lost 4·5 milligrms. in weight. To pass now from the aqueous to the dry reagents. Caustic alkali, when in a state of fiery fusion, as we all know, attacks even platinum very badly. Of ordinary metals, in fact, only *gold* is quite proof against its powerfully corrosive action.* But gold is very expensive, and, what is worse, very soft. Chemists, therefore, generally try to get on as well as they can with fine silver, although this metal, as we know, is not quite proof against the fused reagent, and besides is inconveniently soft and porous. It sucks in fused caustic alkali like a sponge. Even a small silver crucible, after having been used for a caustic alkali fusion, and carefully cleaned, always weighs quite a number of milligrms. more than it did originally. I once had a silver crucible which, although perfectly water-tight, allowed fused caustic potash to slowly filter through its walls. Some six years ago I tried to remedy these defects by alloying the metal with a little nickel; but I found (as Lampadius had done 50 years before) that silver refuses to amalgamate with nickel. But learning from the same authority that nickel readily unites with gold, I made a gold-nickel alloy, and added an excess of it to a relatively large mass of molten silver. There resulted an alloy which had at any rate the expected degree of hardness and elasticity, and Messrs. Johnson, Matthey, and Company had no difficulty in bringing it into the form of a boat for me. This boat has served during the last six years for numerous determinations of organic nitrogen in water residues according to that method which Mr. Robinson and myself published conjointly some years ago, and has been found to hold out far better than, presumably, a plain silver one would have done. This means that it was not attacked by many fusions in it of a mixture of caustic baryta and caustic soda, carried out, however, in an atmosphere of hydrogen. The boat would have been in use this day if I had not cut it up some time ago to ascertain its quantitative composition, which was found to be as follows:—

Silver	91 per cent
Gold	7 „
Nickel..	2 „
	100

With this receipt in their hands, Messrs. Johnson, Matthey, and Company made for me a new boat, and a crucible of the alloy. (Exhibited.) My main object in ordering the new articles was to compare the alloy in regard to resistance to fused alkali with pure silver; but when I was once at it I thought I might as well extend my inquiry to nickel and platinum, and did so. At first sight it appears rather singular that all ordinary metals are attacked by fused caustic alkali, although only a few —namely, tin, zinc, and aluminium—have the power of decomposing its water with evolution of hydrogen and formation of an alkaline metallate. This very forcibly suggests that, in the case of other metals than these three, the corrosive effect is due not to the alkali in itself but to the peroxide formed from it by the action of the atmospheric oxygen. When we fused an ounce of caustic soda in an iron crucible it gets hopelessly contaminated with oxide of iron. The manufacturer, on the other hand, fuses his 10 tons in an iron pot, and produces a snow-white preparation, because in his case the proportion of peroxide produced, as far as it comes into contact with the iron, is vanishingly small. These considerations guided me in my experiments, which, as a rule, consisted in this, that the respective metal was used in the form of a boat, which, after having been charged with the reagent, was placed in a combustion-tube and heated to redness, sometimes in a current of air, sometimes in a current of hydrogen. In the case of the air experiments, a crucible was used occasionally instead of a boat, and, in the special case of platinum, part of the hydrogen trials even were carried out within a crucible provided with an inlet and an outlet tube, soldered autogynically into the well-fitting lid. (Crucible exhibited.) The most important result of my experiments is that the metals examined—namely, silver, the silver-nickel-gold alloy, platinum, and nickel—at even a red heat, are all proof against fused caustic potash, soda, and baryta (BaO_2H_2) *in the absence of air*. Hence, if we want to disintegrate, say, a silicate by fusion with caustic potash or caustic baryta, we may use a platinum crucible, and consequently apply a bright red heat, if we only take care to maintain in the crucible an atmosphere of hydrogen. By means of the crucible which I exhibit I have had no difficulty in decomposing felspar with caustic baryta, so that the "fuse" could have been analysed for potash and soda as well as for the rest of the components. I have not made any such direct trials with caustic potash or soda as a reagent, but am in a position to state that the alkalies, when kept red hot in an atmosphere of hydrogen, fuse quietly, while in the presence of air they boil up and are apt to run over the edge of the vessel. In cases where an atmosphere of hydrogen would be objectionable, as for instance in the case of tin-stone, nitrogen might be substituted for the more volatile gas, and, I have no doubt, would work as well or better. A crucible intended for such alkali fusions, however, should have a shorter outlet pipe than the one which I exhibit, and which, as I may remark in passing, was originally intended for work of an entirely different order. By the conjoint action, at a red heat, of fused alkali and air, all my metals were attacked, silver not excepted, although it must be admitted that it held out best, and appreciably better than even my triple alloy. But whichever of the metals was used, caustic potash always acted more powerfully than caustic soda. Caustic baryta (BaO_2H_2), as far as my experience goes, is a stronger corroder certainly than caustic soda, and not

* To make sure of the correctness of this general assumption, I fused caustic potash in a tray made of pure gold foil, and kept up a bright red heat for a considerable time. The gold remained perfectly bright.

necessarily milder in its action than caustic potash. On silver more especially it seems to act rather more energetically than potash does. To illustrate these general statements I will quote a few examples. The alloy crucible was charged with 19 grms. of pure caustic potash, and the reagent fused and kept at a red heat for twenty minutes. After the surplus water had boiled off the liquid became black, probably through the decompositron of organic matter contained in the reagent,* because the colour disappeared after a time. But the black colour subsequently returned, and became more and more intense through the action of the peroxide formed on the metal. The fuse, when dissolved in water, gave off a gas (probably oxygen) and yielded an abundant black precipitate containing (by analysis) 47 milligrms. of silver (Ag) and 3·4 milligrms. of nickel. The crucible had lost 57·5 milligrms. of its weight. A fine silver basin when subjected similarly to the action of 26 grms. of the same potash (at a somewhat lower temperature) behaved similarly to the alloy crucible; only, apparently, it did not yield so readily to the reagent. Yet the fuse when treated with water gave off gas and yielded a residue weighing 69 milligrms., and containing, by analysis, 58 milligrms. of metallic silver. The basin lost only 6 milligrms. of its weight, showing that it had sucked in caustic alkali. The alloy crucible when treated with 9 grms. of caustic *soda* at a red heat for thirty minutes, lost only 1½ milligrms. of its weight. The fuse dissolved in water with only a slight gas evolution, and formation of a small black precipitate. The silver basin, under similar circumstances, behaved pretty much the same way, but it gained 7·5 milligrms. in weight, proving absorption of soda by its porous metal. A small fine silver basin (of about 35 millimetres diameter and 17 millimetres deep), when subjected to the action of caustic baryta, kept fused in it at a red heat, was strongly attacked, and yet, after having been cleaned, weighed 32 milligrms. more than before. In connection with the present subject one cannot help remembering the conflicting statements of different authorities in regard to the action on platinum of fused lithia. Since the time of Arfvedson, not merely lithia proper but even lithium compounds generally had been credited with quite a characteristically strong corrosive action on platinum at a red heat, until Troost made it out that lithia does not attack platinum unless it be contaminated with rubidia or cæsia, as it very often is in practice. As the proposition bears the stamp of such a distinguished name I felt inclined to accept it as correct, the more so as a few incidental laboratory experiences of my own rather tended to confirm it; but I did not feel quite sure, and accordingly inquired into the matter experimentaily. To procure a lithia sure to be free from potash, rubidia, and cæsia, I dissolved a supply of *Lithium carbonicum purum* from Trommsdorff in Erfurt, in hydrochloric acid, and after addition of an ample excess† of chloride of platinum, evaporated to dryness on a water-bath. The residue was taken up with a mixture of equal volumes of absolute alcohol and absolute ether, the liquor filtered off from the chloroplatinate produced, freed from its ether and part of the alcohol by distillation, and then evaporated to dryness. The residue was reduced in hydrogen at about 300° C., and then dissolved in ether-alcohol to remove the platinum and incidentally what there might be of chloride of sodium. This led to a chloride of lithium, which, although not sure to be quite free from sodium, could not have contained any of the more basilous alkali metals. To convert it into carbonate, without the use of fixed alkali, I evaporated it with a solution of the calculated weight of alkali-free oxalic acid to produce the acid oxalate, which was found to crystallise very readily. Rejecting the mother-liquor, I decomposed the crystals at the lowest possible temperature in a platinum basin, which, to my surprise, led to the formation of a large proportion of charcoal,* to which circumstance it may be owing that the platinum remained unattacked. The residual mixture of carbonate and charcoal was ground up with water, and carbonic acid passed into the mixture to produce a solution of bicarbonate, which was filtered and decomposed by evaporation on a water-bath, so that the bulk of the dissolved carbonate was obtained in the shape of a crystalline crust. This crust was collected, rinsed with water, and accepted as pure carbonate of lithia, Li_2CO_3. Part of this carbonate was converted into lithia by the ordinary process of causticising with lime, the process being conducted in the large nickel basin, by means of pure lime made by igniting pure precipitated carbonate in a platinum crucible. The decanted lithia ley was evaporated down in a large platinum basin, when a deal of carbonate of lime or ($Ca(OH)_2$?) separated out, which was allowed to settle and eliminated by renewed decantation. The thus purified liquor was then evaporated further in a silver basin, the dry residue fused, and preserved as lithia. It turned out a poor apology for real LiOH, as shown by the following analysis:—

	Per cent.
Lithia (Li_2O)	56·53
Carbonic acid (CO_2)	5·57
Lime (CaO)	5·13
Water (by difference)	32·77
	100·00

the composition of a mixture of the formula—

$$0{\cdot}966\ Li_2OH_2O + 0{\cdot}0152\ Li_2O + 0{\cdot}0186\ Li_2CO_3 + 0{\cdot}0486\ CaCO_3.$$

Both preparations acted strongly on platinum vessels when fused in them in the presence of air, and there did not seem to be much difference between the two in regard to the violence of their action. I content myself with quoting an experiment made with the carbonate in a platinum crucible of about 15 c.c. capacity. A quantity of the carbonate was placed in the crucible, and at first heated gently for a time to drive off any water or excess of carbonic acid. The residual dry carbonate (Li_2CO_3?) amounted to 4·413 grms. The heat then was raised to and maintained at full redness for about an hour and a half, the lid being kept on. The fused carbonate crept up at the sides of the crucible, so that some, by travelling along the lid, reached the frame and coloured it crimson. The crucible, especially at those parts of the side which were only, so to say, varnished over with the reagent, was very perceptibly attacked. To increase the effect, a coil of platinum foil was now placed in the crucible, the lid put "half on," and the heating resumed and continued for other two hours. The crucible and contents were now allowed to cool, and weighed, when it was found that the contents weighed 0·161 grm. less than the original carbonate. All the visible inside of the crucible had assumed a dark olive-green colour. To analyse the product the crucible with its contents was placed in a cylinder rigged up as part of an apparatus for the direct determination of carbonic acid. In it the product was decomposed by dilute sulphuric acid, the carbonic acid collected in a potash bulb and soda-lime tube and weighed. An aliquot part of the solution left served for the determination of the lithia as sulphate.

Results.

Original carbonate	4·413 grms.
Total residue in crucible at the end of the heating	4·252 ,,
Containing CO_2	2·313 ,,
And lithia equal to Li_2SO_4	6·543 ,,

This agrees with the assumption that the residue was a mixture containing—

* It was "potasse à l'alcool."

† "Excess" to be taken in reference to the non-lithium presumably present.

* The oxalic acid had been prepared by the decomposition of oxalate of methyl by water, and may have contained methyl-oxalic acid.

Carbonate or lithia (Li_2CO_3)	91·49	parts.
Binoxide of lithium (Li_2O_2)	7·49	,,
Extra oxygen (by difference)	1·02	,,
	100·00	,,

The crucible and coil, after the sulphuric acid treatment, were washed with water, dried, and weighed. They had gained 22 milligrms., which happens to be just about one-half of the "extra oxygen" reported as it is when reduced to absolute weight. But this latter quantity is burdened with the observational errors in the determination of the carbonic acid and lithia and the total substance, and consequently affords no safe ground for further conclusions. In an atmosphere of hydrogen neither of the two lithia preparations attacked platinum in the least, even when kept in contact with it for hours at a red-heat; but both lost weight to quite an unexpected extent, although the amount of lithia volatilised seemed to have been small in all cases.

In the case of the carbonate the change was more minutely studied. A small platinum crucible, containing 4·219 grms. of carbonate of lithia (recently dehydrated in it at a gentle heat), was placed in the platinum crucible, provided with inlet and outlet tubes, and heated within it for many hours over a good Iserlohn burner,* while a current of dry hydrogen passed through the apparatus to keep out the air. From time to time the heating was stopped, and the residue examined and weighed. There always was a small sublimate on the inside of the lid of the outer crucible, which was weighed, to be allowed for in the calculation of the loss of volatile matter up to the respective time, and removed before the process was resumed. The corrected loss was very considerable in the earlier periods of heating, but became less and less as the process progressed. It was also noticed that the substance while losing carbonic acid became more and more difficultly fusible. Calculating from the weights of the successive residues and sublimates obtained, and on the assumption that the aggregate (duly corrected) loss was just carbonic acid (lost and not replaced by water), the ultimate residue was very nearly of the composition $Li_2O + \frac{1}{10}CO_2$. A determination of the carbonic acid, by the direct method, and of the lithia (as Li_2SO_4) gave the following results:—

Lithia (Li_2O)	$88·27 \div 30 = 2·942$
Carbonic acid (CO_2)	$7·50 \div 44 = 0·171$
Water (? by difference)	$4·23 \div 18 = 0·235$
	100·00

These numbers agree with the formula—

$$Li_2O + 0·13(H_2O \text{ or } CO_2).$$

Part of this product was utilised for studying its action on platinum in the presence of air. But as a number of days had elapsed before this could be done, and the substance meanwhile had been standing in the crucible (within an exsiccator), we first re-heated it in hydrogen gas within the same platinum apparatus as had been used before, with this difference, however, that after thirty minutes' application of an Iserlohn burner the heating was continued for twenty minutes over a gas blowpipe. Weight of substance operated upon equal 0·4692 grm.; total loss equal 79 milligrms., which is (by 24 m.grms.) more than the weight of ($CO_2 + H_2O$) calculated for 0·4692 grm. of $Li_2O + 0·13(H_2O \text{ or } CO_2)$, showing that the substance while in the exsiccator had absorbed water or carbonic acid. But obviously the substance, by being re-heated, had come still closer in its composition to plain Li_2O. It had assumed a gray colour, and showed only signs of incipient fusion. This gray substance was now heated within the same apparatus, in a current of dry air, a gas blowpipe supplying the heat. As part of the substance was lost accidentally, the residue was not weighed. It was now of a perfectly white colour, although the empty part of the crucible, through the conjoint action of the air and the vapour of lithia produced, had got badly attacked. This residue again stood in an exsiccator for some days before we had time to analyse it. To remove any absorbed water or carbonic acid we began by re-heating it in hydrogen. 0·347 grm. of the re-heated substance, when subjected to the action of water, dissolved only very slowly, with evolution of very little heat. Without waiting for a complete solution we added excess of sulphuric acid, evaporated to dryness, and weighed the sulphate. It amounted to 1·2459 grm. corresponding to 97·9 per cent of Li_2O in the substance analysed. To sum up: Carbonate of lithia, when ignited in a platinum crucible in air, attacks the metal, and is itself largely converted into peroxide. A considerable percentage, however, of Li_2CO_3 remains as such. When it is heated in hydrogen it does not attack the metal, but gradually loses more and more of its carbonic acid, so that at last almost pure Li_2O is left as an almost infusible solid, which acts only very slowly on water; and consequently is widely different from what the oxides K_2O and Na_2O are suppposed to be. (I have no personal experience regarding these myself.) In order to see whether the hydrogen, in reducing the carbonate, acts chemically, perhaps by removing the CO_2 as CO and H_2O, or merely as a supporter of dissociation—*i.e.*, by preventing accumulation of carbonic acid within the crucible's atmosphere—a known weight of carbonate of lithia was heated (within the same platinum apparatus as had served in the hydrogen experiments) in a current of dry nitrogen gas. But as our stock of specially purified carbonate of lithia was exhausted, we operated upon commercial *Lithia carb. puriss.*, as obtained from Trommsdorff. The following weighings were recorded:—

	Grm.
Original substance	0·7227
After preliminary dehydration at a gentle heat in nitrogen gas	0·7180
Heated over blowpipe for fifteen minutes.	

The out-going nitrogen, when blown through a flame, coloured it strongly red. Neglecting this loss of Li_2O, and assuming the 0·239 grm., which the 0·7180 of Li_2CO_3 had lost, to be all carbonic acid, it represents 33·40 out of the 59·46 per cent of CO_2 present in the original carbonate. The platinum remained, unattacked. The heating in nitrogen was resumed, but the experiment miscarried, which is of no consequence, because the result already obtained clearly proved that we have to deal with dissociation pure and simple. I intend to inquire more fully into the behaviour of Li_2CO_3 and of LiOH when heated in hydrogen or other gases, and to extend my inquiry to the potassium, sodium, and barium compounds.

In conclusion, it is an agreeable duty to me to acknowledge the very able and zealous manner in which I was supported by Mr. Robert Anderson in the execution of the many experiments involved in this investigation.—*Journal of the Society of Chemical Industry.*

* A powerful Bunsen, constructed on the Argand principle.

THE "DROP" METHOD OF CHEMICAL ANALYSIS.

By Dr. H. HAGER.

The customary methods for testing medicinal agents, which are both tedious and require a larger quantity of material, can be superseded by a method which requires merely single drops of the reagent, as well as of the liquid to be examined. For this method the following reagents are needed:—

Red and blue litmus paper and turmeric paper.

Extract of indigo paper, which is turned yellow by hot nitric acid and caustic alkalies, but not by ammonia.

Rosaniline paper as a test for alcohol.

Potassium ferrocyanide paper as a reagent for ferric

salts (blue), copper and uranium (deep brown), gold (greenish brown), platinum (brownish green to reddish), thallium and vanadic acid (yellow).

Potassium sulphocyanide paper is turned decidedly yellow by bismuth nitrate, bluish black by salts of copper, red by solution of gold, white by mercuric nitrate, black by mercurous nitrate, and blood-red by ferric salts.

Potassium iodide paper is turned red by mercuric salts, green by mercurous salts, yellow by solution of lead. For detecting chlorates 2 to 3 c.c. of the liquid are placed in a small test-tube along with a slip of the paper; 1 c.c. of dilute sulphuric acid is then added, and heat is applied. If chlorate is present the liquid turns yellow.

Mercurous nitrate paper serves when moistened to detect ammonical gas, which turns it black; caustic alkalies and alkaline mono-carbonates stain it greenish-brown to black, whilst the alkaline bicarbonates leave it colourless.

Silver bichromate paper turns yellow with free hydrochloric acid.

Besides these the author mentions a number of other papers less frequently needed. The use of all consists in letting a drop of the liquid in question fall upon a slip of the paper.

The author tests for arsenic (arsenious and arsenic acids) by means of slips of sheet brass, 2·5 to 3 centimetres in length and 15 to 17 centimetres in length. The hydrochloric solution is mixed with a little oxalic acid, or the ammonical solution is supersaturated with hydrochloric acid and mixed with oxalic acid in order to reduce arsenic to arsenious acid. A drop of the solution is put upon a brass plate and sharply dried; the place of the drop is then washed with water, when a dark spot of a permanganate colour reveals the presence of arsenic. Dark thin outlines still appear in case of dilution with 150,000 parts.

In cases where the papers and the brass plate are not used the author places the two drops (of the reagent and the liquid in question) near each other upon a slip of glass and mixes them. The transparency of the glass renders the slightest turbidity visible.—*Pharmaceut. Central-Halle and Chemiker Zeitung.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING MAY 31ST, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, June 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from May 1st to May 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 189 samples of water, the whole were, without exception, clear, bright, and well filtered.

The quality of the water supplied to the Metropolis during the past month, as indicated by its state of aëration, and high degree of freedom from colour and excess of organic matter, was excellent. Its perfect filtration was shown by the absence of even a trace of suspended matter in any one of the numerous samples submitted to examination.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B., Chief Chemist to the U.S. Geological Survey, Washington.

LANTHANUM.

LEAVING out of account the work of Mosander, and the valueless experiments of Choubine, we may consider the estimates of the atomic weight of lanthanum which are due to Hermann, Rammelsberg, Marignac, Czudnowicz, Holzmann, Zschiesche, Erk and Cleve.

From Rammelsberg† we have but one analysis. 0·700 grm. of lanthanum sulphate gave 0·883 grm. of barium sulphate. Hence 100 parts of $BaSO_4$ are equivalent to 79·276 of $La_2(SO_4)_3$.

Marignac,‡ working also with the sulphate of lanthanum, employed two methods. First, the salt in solution was mixed with a slight excess of barium chloride. The resulting barium sulphate was filtered off and weighed; but, as it contained some occluded lanthanum compounds, its weight was too high. In the filtrate the excess of barium was estimated, also as sulphate. This last weight of sulphate, deducted from the total sulphate which the whole amount of barium chloride could form, gave the sulphate actually proportional to the lanthanum compound. The following weights are given:—

$La_2(SO_4)_3$.	$BaCl_2$.	1st $BaSO_4$.	2nd $BaSO_4$.
4·346 grms.	4·758 grms.	5·364 grms.	0·115 grm.
4·733 ,,	5·178 ,,	5·848 ,,	0·147 ,,

Hence we have the following quantities of $La_2(SO_4)_3$ proportional to 100 parts of $BaSO_4$. Column A is deduced from the first $BaSO_4$ and column B from the second, after the manner above described:—

A.	B.
81·022	83·281
80·934	83·662
Mean $80·978 \pm 0·030$	Mean $83·471 \pm 0·128$

From A .. .. .. La = 138·776
,, B .. .. .. ,, 147·474

A agrees best with other determinations, although, theoretically, it is not so good as B.

Marignac's second method, described in the same paper with the foregoing experiments, consisted in mixing solutions of $La_2(SO_4)_3$ with solutions of $BaCl_2$, titrating one with the other until equilibrium was established. The method has already been described under cerium. The weighings give maxima and minima for $BaCl_2$. In another

* Smithsonian Miscellaneous Collections. The Constants of Nature."

† *Poggend. Annal*, 55, 65.

‡ *Arch. des Sci. Phys. et Nat.*, (1), 11, 29. 1849.

column I give $La_2(SO_4)_3$ proportional to 100 parts of $BaCl_2$, mean weights being taken for the latter:—

$La_2(SO_4)_3$.	$BaCl_2$.	Ratio.
11·644 grms.	12·765—12·825 grms.	91·004
12·035 ,,	13·195—13·265 ,,	90·968
10·690 ,,	11·669—11·749 ,,	91·297
12·750 ,,	13·920—14·000 ,,	91·332
10·757 ,,	11·734—11·814 ,,	91·362
12·672 ,	13·813—13·893 ,,	91·475
9·246 ,,	10·080—10·160 ,,	91·364
10·292 ,,	11·204—11·264 ,,	91·615
10·192 ,,	11·111—11·171 ,,	91·482

Mean 91·322 ± 0·048

Hence La = 140·484.

Although not next in chronological order, some still more recent work of Marignac's* may properly be considered here. The salt studied was the sulphate of lanthanum, purified by repeated crystallisations. In two experiments the salt was calcined, and the residual oxide weighed; in two others the lanthanum was precipitated as oxalate, and converted into oxide by ignition. The following percentages are given for La_2O_3:—

57·56, 57·58 } By calcination.
57·50, 57·55 } Ppt. as oxalate.

Mean 57·5475 ± 0·0115

The atomic weight determinations of Holzmann† were made by analyses of the sulphate and iodate of lanthanum, and the double nitrate of magnesium and lanthanum. In the sulphate experiments the lanthanum was first thrown down as oxalate, which, on ignition, yielded oxide. The sulphuric acid was precipitated as $BaSO_4$ in the filtrate.

$La_2(SO_4)_3$.	La_2O_3.	$BaSO_4$.
0·9663 grm.	0·5157 grm.	1·1093 grm.
0·6226 ,,	0·3323 ,,	0·7123 ,,
0·8669 ,,	0·4626 ,,	0·9869 ,,

These results are best used by taking the ratio between the $BaSO_4$, put at 100, and the La_2O_3. The figures are then as follows:—

46·489
46·652
46·873

Mean 46·671 ± 0·075

In the analyses of the iodate the lanthanum was thrown down as oxalate, as before. The iodic acid was also estimated volumetrically, but the figures are hardly available for present discussion. The following percentages of La_2O_3 were found:—

23·454
23·419
23·468

Mean 23·447 ± 0·0216

The formula of this salt is $La_2(IO_3)_6.3H_2O$.

The double nitrate, $La_2(NO_3)_6.3Mg(NO_3)_2.24H_2O$, gave the following analytical data:—

Salt.	H_2O.	MgO.	La_2O_3.
0·5327 grm.	0·1569 grm.	0·0417 grm.	0·1131 grm.
0·5931 ,,	0·1734 ,,	0·0467 ,,	0·1262 ,,
0·5662 ,,	0·1647 ,,	0·0442 ,,	0·1197 ,,
0·3757 ,,	— ,,	0·0297 ,,	0·0813 ,,
0·3263 ,,	— ,,	0·0256 ,,	0·0693 ,,

These weighings give the subjoined percentages of La_2O_3:—

21·231
21·278
21·141
21·640
21·238

Mean 21·3056 ± 0·058

These data of Holzmann give values for the molecular weight of La_2O_3 as follows:—

From sulphate	La_2O_3 = 325·674	± 0·522
,, iodate	,, 322·419	0·113
,, magnesian nitrate ..	,, 324·355	0·923

Czudnowicz* based his determination of the atomic weight of lanthanum upon one analysis of the air-dried sulphate. The salt contained 22·741 per cent of water.

0·598 grm. gave 0·272 grm. La_2O_3 and 0·586 grm. $BaSO_4$.

The La_2O_3 was found by precipitation as oxalate and ignition. The $BaSO_4$ was thrown down from the filtrate. Reduced to the standards already adopted these data give for the percentage of La_2O_3 in the anhydrous sulphate the figure 58·668. 79·117 parts of the salt are proportional to 100 parts of $BaSO_4$.

Hermann† studied both the sulphate and the carbonate of lanthanum. From the anhydrous sulphate, by precipitation as oxalate and ignition, the following percentages of La_2O_3 were obtained:—

57·690
57·663
57·610

Mean 57·654 ± 0·016

The carbonate, dried at 100°, gave the following percentages:—

68·47 La_2O_3.
27·67 CO_2.
3·86 H_2O.

Reckoning from the ratio between CO_2 and La_2O_3 the molecular weight of the latter becomes 325·896.

Zschiesche's‡ experiments consist of six analyses of lanthanum sulphate, which salt was dehydrated at 230,° and afterwards calcined. I subjoin his percentages, and in a fourth column deduce from them the percentage of La_2O_3 in the *anhydrous* salt:—

H_2O.	SO_3.	La_2O_3.	La_2O_3. in anhydrous salt.
22·629	33·470	43·909	56·745
22·562	33·306	44·132	56·964
22·730	33·200	44·070	57·034
22·570	33·333	44·090	56·947
22·610	33·160	44·240	57·150
22·630	33·051	44·310	57·277

Mean 57·021 ± 0·051

Erk‖ found that 0·474 grm. of $La_2(SO_4)_3$, by precipitation as oxalate and ignition, gave 0·2705 grm. of La_2O_3, or 57·068 per cent. 0·7045 grm. of the sulphate also gave 0·8815 grm. of $BaSO_4$. Hence 100 parts of $BaSO_4$ are equivalent to 79·921 of $La_2(SO_4)_3$.

Last of all, and probably best of all, we come to the determinations of Cleve.§ Strongly calcined La_2O_3, spectroscopically pure, was dissolved in nitric acid, and then, by evaporation with sulphuric acid, converted into sulphate:—

* *Ann. d. Chim. et de Phys.*, (4), 30, 68. 1873.
† *Journ. f. Prakt. Chem.*, 75, 321. 1858.

* *Journ. f. Prakt. Chem.*, 80, 33. 1860.
† *Ibid.*, 82, 396. 1861.
‡ *Ibid.*, 104, 174.
‖ *Jenaisches's Zeitschrift*, 6, 306. 1871.
§ *K. Svenska. Vet. Akad. Handlingar*, Bd. 2, No. 7 1874.

1·9215 grms. La_2O_3	gave	3·3365	sulphate.	57·590 per cent.
2·0570 ,,		3·5705	,,	57·611 ,,
1·6980 ,,		2·9445	,,	57·667 ,,
2·0840 ,,		3·6170	,,	57·617 ,,
1·9565 ,,		3·3960	,,	57·612 ,,

Mean 57·619 ± 0·0085

From the last column, which indicates the percentage of La_2O_3 in $La(SO_4)_3$, we get, if $SO_3=80$, $La=139·15$.

We may now combine the similar means into general means, and deduce a value for the atomic weight of lanthanum. For the percentage of oxide in sulphate we have six estimates, as follows. The single experiments of Czudnowicz and of Erk are assigned the probable error and weight of a single experiment in Hermann's series :—

Czudnowicz	58·668 ±	0·027
Erk	57·668	0·027
Hermann	57·654	0·016
Zschiesche	57·021	0·051
Marignac	57·5475	0·0115
Cleve	57·619	0·0085
General mean ..	57·620	0·0059

For the quantity of $La_2(SO_4)_3$ proportional to 100 parts of $BaSO_4$, we have five experiments, which may be given equal weight and averaged together :—

Marignac	81·022
,, ...	80·934
Rammelsberg	79·276
Czudnowicz	79·117
Erk	79·921

Mean 80·054 ± 0·270

In all, there are seven ratios from which to calculate :—

(1). Percentage of La_2O_3 in $La_2(SO_4)_3$, 57·620 ± 0·0059
(2). $BaCl_2 : La_2(SO_4)_3$ :: 100 : 91·322 ± 0·048—Marignac.
(3). $BaSO_4 : La_2(SO_4)_3$ :: 100 : 80·054 ± 0·270
(4). $BaSO_4 : La_2O_3$ :: 100 : 46·671 ± 0·075—Holzmann.
(5). P.c. of La_2O_3 in iodate, 23·447 ± 0·0216—Holzmann.
(6). ,, ,, magnesian nitrate, 21·3056 ± 0·058 —Holzmann.
(7). ,, ,, carbonate, 68·47—Hermann.

These ratios give five values for the molecular weight of lanthanum oxide, and two for that of the sulphate :—

From (2)	$La_2(SO_4)_3=568·488$ ±	0·320
,, (3)	,, 558·624	1·888
General mean ..	,, 568·212	0·316

Hence La = 140·346 ± 0·160.

From (1)	$La_2O_3=325·791$ ±	0·074
,, (4)	,, 325·674	0·522
,, (5)	,, 322·419	0·113
,, (6)	,, 324·355	0·923
,, (7)	,, 325·896	0·488
General mean ..	,, 324·810	0·061

Here the value derived from ratio (7) is given the weight of a single experiment in ratio (1). Hence La = 138·460 ± 0·031.

Combining the two values for La, we get this final result :—

From La_2O_3	La = 138·460 ±	0·031
,, $La_2(SO_4)_3$	,, 140·346	0·160
General mean ..	,, 138·526	0·030

Or, if O = 16, La = 138·844.

Since this value is a little under and Cleve's a little over 139, the latter figure may fairly be used in all calculations involving a knowledge of the atomic weight of lanthanum.

The following additional note has been communicated by the author :—

Later determinations of the atomic weight of lanthanum, by Brauner and Cleve, essentially modify the conclusions stated in this chapter. In a first paper,* Brauner gives two experiments upon the synthesis of the sulphate from the oxide : which, expressed in percentages, give 57·5775 of La_2O_3 in 100 of $La_2(SO_4)_3$. In a second paper,† with purer material, the mean percentage in five experiments is 57·480.

Cleve,‡ with the same method, and very pure material, also gives a mean percentage of 57·480, from twelve experiments. Hence La = 138·019. If $SO_3=80$, La = 138·22. These results supplant all previous determinations of this constant.

NOTICES OF BOOKS.

A Treatise on Earthy and other Minerals and Mining. By D. C. DAVIES, F.G.S. London : Crosby Lockwood and Co.

THIS book is devoted to an account of the more important minerals, their properties, localities, and mining. The so-called useful and the precious or noble metals—in short, all those which are commonly used in the metallic state—have been discussed by the author in a previous treatise on "Metalliferous Minerals and Mining."

The notice of common salt as a mineral is very elaborate. We find, among other unusual information, a history of the salt works of Cheshire and Worcestershire from the earliest times on record. The account of the salt deposits near Middlesbrough does not seem to be brought down to the present date, so that the reader remains in doubt whether the operations of Messrs. Bolckow and Vaughan, and of Bell Brothers, have proved commercially successful. It has always been understood that the want of a supply of salt on the spot has been one main reason why the alkali trade on the Tyne has been less flourishing than that in South-west Lancashire. The account given of the great Wieliczka mine is very correct, as we know from personal examination.

The most enormous deposit of salt in the world is probably that on the Indus, of which the author gives an account taken from the "Memoirs of the Geological Survey of India."

The potash deposits of Stassfurt do not seem to be mentioned, though sylvine is noticed as occurring along with the rock-salt of Salzburg.

Under borax we find a very good account of the sources of this useful mineral, the recently discovered deposits in Nepaul and Iceland being mentioned. The Chilian sources of borax seem to have been overlooked.

The total annual output of witherite (native barium carbonate) in Great Britain and Ireland is given as 21,313 tons. Considering the poisonous nature of this mineral it is surprising that those authorities who are constantly clamouring for additional restrictions on the sale of poisons,—at whatever inconvenience to the industrial arts,—have not proposed to have a constant guard stationed at all mines and accessible deposits of witherite.

The value of fluor-spar is stated at about 14s. per ton. This is doubtless correct as regards fragments, but large blocks of "blue john," without a flaw, as sometimes met

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* *Journ. Chem. Soc.* Feb., 1882.
† *Sitzungsb. Akad. Wein.*, June, 1882.
‡ *Bulletin de la Soc. Chimique*, 39, 131. 1883.

with at Castleton, are worth more than twenty times that sum.

The sources of alum are scarcely treated in a satisfactory manner. There is no mention of the alunite of La Tolfa which serves for the manufacture of the famous Roman alum. The alum manufacture at Whitby is now abandoned. At least, having occasion to visit the locality a few years ago, we found the works gone to decay, and were told that alum-making had ceased for some time. The quarries were occupied merely by a few men who were picking out stones used in the manufacture of cement. In fact the chief raw materials used in alum-making are now China clay and bauxite.

The account of phosphate of lime occupies four chapters and almost rises to the rank of a monograph. Coprolite mining, which at one time was a very important industry in Suffolk, Cambridgeshire, and Bedfordshire, and which even extended into Buckinghamshire, has seriously fallen. The annual value raised, which in 1875 was £627,000, had in 1882 dwindled to £86,628. This decline is partly due to the exorbitant royalty demanded by the landowners, which ranges from £100 to £140 per acre, whilst the average field of coprolites is about 300 tons per acre, worth perhaps fifty shillings per ton. "When it is considered that the digger has to turn over from 3 to 15, sometimes 20 feet of soil and sand, and to restore the land afterwards to its original condition; that he has also to wash, sort, and convey the nodules to a railway, it will be plain that the price paid to the landowner is too much, and that in the face of phosphates more cheaply won abroad, English phosphate digging can hardly be profitably carried on."

In the chapter on the diamond we find a quotation from the *Geographical Magazine* for 1868 which, in the light of subsequent experience, reads strangely. Says the writer—whose name is charitably withheld—"I can only now conclude by expressing my conviction that the whole diamond discovery in South Africa is an imposture, a bubble scheme!"

In the chapter on bitumen, petroleum, &c., we notice the following passage:—"About one hundred and thirty years ago the *Philosophical Transactions*, the *Transactions of the Royal Society of Great Britain*, and the scientific papers of other countries of Europe, &c." The above sentence is misleading. The *Philosophical Transactions* are the *Transactions of the Royal Society*. Probably the author meant to say in the second place, the "*Proceedings of the Royal Society*."

In speaking of sulphur and sulphur ores Mr. Davies gives a discouraging view of the sulphur deposits of Iceland.

Taken as a whole this work will prove exceedingly useful as a manual of reference to all persons interested in the industries discussed.

OBITUARY.

HENRY WATTS, F.R.S.

With great regret we have to announce the sudden death of Mr. Henry Watts, on the 30th ultimo, of syncope of the heart. Mr. Watts was born in London on the 20th January, 1815. He was educated first at a private school in London, and subsequently attended lectures at the University College, London. In 1841 he graduated as Bachelor of Arts in the University of London. In 1846 he entered the Birkbeck Laboratory of Chemistry, then recently established at University College, as Assistant to his highly-valued friend, the late Professor Fownes, and in that capacity was engaged in directing the work of the students till the death of Professor Fownes in 1849, and afterwards till 1857 under Professor Williamson. In 1848 he was engaged by the Cavendish Society to prepare a translation, with additions, of the great "Handbuch der Chemie," of Leopold Gmelin, a work which extended to 18 volumes, and occupied a large portion of his time for more than twenty years, the last volume and index having been published in 1872. In 1858 he was engaged by the eminent publishers, Messrs. Longmans and Co., to prepare a new edition of "Ure's Dictionary of Chemistry and Mineralogy," but finding that this book, the last edition of which appeared in 1831, had fallen too much behind the existing state of chemistry to be made the groundwork of a dictionary adapted to the requirements of the time, he undertook, with the consent of the publishers, and the assistance of a staff of contributors distinguished for their attainments in different branches of physics and chemistry, the compilation of a new "Dictionary of Chemistry and the Allied Branches of other Sciences." This work, in five large octavo volumes, was completed in 1868, but as additions were required to keep it abreast of the continual advances of science, a supplementary volume was published in 1872, a second supplement in 1875, and a third (in two parts) in 1879 and 1881.

Mr. Watts also brought out three editions of "Fownes's Manual of Chemistry," viz., the 10th, published in 1868, the 11th in 1872, and the 12th in 1877.

He held for many years the appointments of editor of the *Journal*, and Librarian, to the Chemical Society, having been appointed to the former in 1850, and to the latter in 1861. He was elected a Fellow of the Chemical Society in 1847, a Fellow of the Royal Society in 1866, and a Member of the Physical Society in 1879. He was also an Honorary Member of the Pharmaceutical Society, and a Life Governor of University College.

He was engaged at the time of his death in writing a new and abridged edition of the "Dictionary of Chemistry." He was also editing a re-edition of "Richardson and Watts's Technology," and the 13th edition of "Fownes's Manual of Chemistry," of which the 2nd volume is left in manuscript.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 8, April 20, 1884.

Formation-Heat of Antimony Fluoride, Chloride, and Oxy-Chlorides.—M. Guntz.—The author gives his results in the form of tables.

Decomposition of Cements by Water.—H. Le Chatelier.—The author has observed that the lime removed from cements by the action of water is not free, as generally supposed, but in a state of combination.

Preparation of a Propyl and an Amyl-Naphthalin.—Léon Roux.—To obtain the former of these compounds the author heats in a flask fitted with a reflux-condenser a mixture of 200 grms. naphthalin and 120 grms. propyl bromide. When the latter begins to distil over about 10 grms. aluminium chloride are added in small proportions, shaking up the flask each time. When about the theoretical quantity of hydrobromic acid has come over, the flask is let cool, and from 300 to 400 grms. of carbon disulphide are added. The resulting matter is treated with water to decompose the aluminium chloride. The carbon disulphide is decanted off, dried, and distilled in the water-bath. There remains finally a brown, pasty mass, which is submitted to fractionated distillation. The compound in question passes over between 145° to 150° under a pres-

sure of 2 centimetres to mercury. Amyl-naphthalin is obtained in a similar manner, using amyl-chloride.

Action of the Chlorised Aldehyds upon Benzol.—A. Comtes.—The author has obtained an aldehyd, $C_8H_6Cl_2O$, which is very stable and may be distilled in a vacuum without decomposition. It reduces Fehling's liquid and silver nitrate energetically, and combines with sodium bisulphite, although with difficulty.

Influence of the Ammonia-Soda Process upon the Value of Hydrochloric Acid and of Chlorine.—W. Weldon.—From the *Journal of the Society of Chemical Industry*.

Analysis of Soils.—Antony Guyard.—The mineral products useful as plant-food and which require to be determined in the analysis of soils exist mainly in two forms:—In a state readily assimilable in the mineral portion and in an assimilated state in the organic portion. In order to obtain the former in a separate state the author treats in the cold 100 grms. of soil with a refrigerated mixture of 150 c.c. hydrochloric acid with an equal volume of water. He filters and washes at first with cold water, and then with boiling water until it is exhausted, and in the solution he determines lime, magnesia, alkalies, and phosphoric acid. He thinks it advisable not to reduce samples of soil to an impalpable powder, and, on the other hand, that stones, &c., should be broken up, ground, passed through the same sieve, and mixed with the rest of the sample. To obtain the assimilated elements he ignites 100 grms. of soil at as low a heat as possible, stirring until all the carbon is burnt off. This portion, when cold, is treated with 300 c.c. of dilute hydrochloric acid, and exhausted as above.

Russian Chemical Society.—November 3/15, 1883.—M. Tchijevsky sent in an account of his preliminary experiments on the volatilisation of different salts on the evaporation of their aqueous solutions. From his researches it results that the quantities of the salt carried away with watery vapour in the evaporation of solutions are sometimes very considerable. The volatilisation of the salt increases with the concentration of the solutions up to a certain maximum, and then decreases. It increases also directly as the molecular weight of the salt.

M. Kajander sent a communication on certain corrections which must be introduced into thermo-chemical data.

M. Kutcheroff explained the result of his studies on the action of allylene upon mercuric oxide and its salts.

M. Prokofieff discussed the analogy existing between the compounds of boron and those of the residue C_2H_3 contained in acetic acid.

M. Louguinine communicated the results of his researches on the combustion-heat of several acetones and of ethyl-carbonate.

M. Wroblevsky called attention to the contradictions which result if we express the structure of benzol by the prismatic formula.

M. Bakmetieff exhibited an automatic apparatus for washing precipitates with hot water.

M. L. Wagner gave an analysis of the epidermis in a case of red tettors.

M. Sokoloff gave the results of an analysis of the water of the Neva during October last.

MM. Sabanieff and Kislakowsky have studied the product obtained from the action of ethylene bibromide upon naphthalin in presence of aluminium chloride. The authors suppose that the hydrocarbon obtained is picene.

M. Konovaloff gave a communication on the decomposition of solutions.

The 8th part of vol. xv. of the *Journal of the Russian Chemical Society* contains the following memoirs:—

Analysis of a Phosphorite from Nijni-Novgorod, by M. Lutavine. It contains 25 per cent of phosphoric acid and appears to be apatite mixed with calcium carbonate, quartz, and some zeolite.

On the β-dipropyl-acrylic acid obtained from β-dipropyl-ethyleno-lactic acid, by M. Albitzky.

On the action of allyl iodide and zinc upon epi-chlorhydrin, by M. Lopatkine.

On the composition of the accessory product obtained on the preparation of diallylcarbinol, by M. Chestakoff.

Action of a mixture of allyl iodide and primary isobutyl iodide upon acetone in presence of zinc, by M. Chatzky.

On the hydrocarbon, C_8H_{14}, derived from allyl-diethyl-carbinol, by M. Reformatzky.

The specific refractive energy of the hydrocarbon, $C_{12}H_{20}$, by M. Albitzky.

Theory of solutions, by M. Alexeef.

On diphenyl-xylyl-methane and its oxidation products, by M. Hemilian.

Meeting of December 1/13, 1883.—The President announced that the committee chosen to award the Sokaloff prize proposed to allot it to M. Gustavson, for the discovery and study of the reactions of organic substances in presence of aluminium chloride, bromide, and iodide.

M. Parloff and M. Poehl gave the results of analyses of the water of the Neva.

P. Alexeeff gave an account of new researches on azocuminic acid.

Researches from the Chemical Laboratory of the University of Kiew were handed in.

On the structure of the nitro-compounds of the fatty series, by M. Kissel.

Analyses of the mineral waters of the Caucasus, by M. Barsilovsky.

On the structure of indigo blue, by M. Alexeef.

M. Smolensky communicated analyses of the waters of the lakes and wells of Schouvaloff, and of the rivers Oxta and Loupa.

M. Lukianoff sent in a memoir on the composition of the aniline oils.

MM. Gorboff and Kessler announce that dimethacrylic acid (obtained by the action of CHI_3 upon sodium isobutylate) is split up into isobutylene and CO_2 if heated to 210° to 220° for 25 to 30 hours.

M. Wilm has obtained a rhodium salt of the composition $R_2Cl_4,8NH_4Cl+7H_2O$.

M. Prjybtek gave a preliminary communication on the product of the action of caustic potassa upon the dichlorhydrine of erythrite.

M. Alexeef has studied the change which the dissolving heat of isobutylic alcohol in water undergoes according to the temperature of the experiment.

The 9th part of vol. xv. of the *Journal of the Russian Chemical Society* contains the following memoirs:—

Thermic data relating to pyro-sulphuryl chloride, by M. Konovaloff.

On the hydrate of silica obtained from the decomposition of cast-iron, by M. Zaboudsky.

The action of allylene upon mercuric oxide and its salts, by M. Kutcheroff.

On the corrections of thermo-chemical data, by M. Kajander.

Moniteur Scientifique, Quesneville.
Vol. xiv., May, 1884.

Colours employed in Calico-Printing and the General Means of fixing them upon the Cloth.—R. Bourcart (of Manchester).—A continuation from the April number, extending to nearly 50 pages, and being from its nature quite incapable of useful abstraction.

Industrial Society of Mulhouse.—Meeting of March 12th, 1884.—M. Goppelsroeder sent a letter on the possibility of utilising in chemical telegraphy the electrolytic reactions which he has described in his different publications,—the simultaneous formation and fixation of colouring-matters upon cloth, paper, &c., as well as the discharge of colours fixed upon the same materials.

M. Dominique Sifferlen, of Moscow, sent a note on a means of utilising worn caoutchouc cloths for covering

the wooden rollers of washing machines. Certain sealed notes were opened, including one by M. Rosenstiehl (No. 188, Dec. 16th, 1872), on an improvement in printing by relief engraving, by means of caoutchouc rollers; another by the same author (No. 187, of the same date) on "toluidine brown"; a third by MM. Poirrier and Lauth (No. 185, Oct. 31st, 1872), on "a secondary product of the manufacture of dimethyl-aniline, and the colouring matters derived from it. These three papers were ordered to be printed. A note by M. Mulhauser (No. 198, Oct. 4th, 1873) on "the synthesis of certain derivatives of indigo," contained merely theoretical speculations, and was deposited in the archives.

M. Horace Kœchlin submitted swatches dyed and printed with canarine, by MM. Prochoroff and O. Müller. The procedure followed was :—1 part of canarine is heated to a boil with 20 parts of distilled water; 1 part of potassa is added, and the mixture is heated until the solution is complete and the liquid takes a brown colour; from 7 to 10 parts per cent of soap are added and the mixture is let cool for working. Calcium and magnesium salts precipitate the colouring-matter. Caustic soda cannot be used in place of potassa, as the sodium compound is insoluble in the cold. The canarine should not be heated too long with the potassa, or decomposition may set in. Cold solutions should be used for padding, to prevent unevenness. The pieces opened out are passed into a cistern with rollers, containing 80 litres of water and 60 litres of solution of canarine. They are wrung out, left in heaps for 4 to 6 hours, washed and soaped at a boil. M. Kœchlin modifies the process, boiling 100 grms. canarine, 100 borax, and 1 litre of water. In dyeing, he raises the temperature gradually, as is done with alizarin.

Chemical Patents and Certificates of Addition taken in France during the year 1884.—An enumeration of patents, drawn up so briefly as to throw little light on their character.

Fermentation of Indigo Vats.—L. Benoist.—The author argues that the reduction of the indigo in the warm vats is effected by anærobic microbia. Under their influence the sugar is converted into butyric and succinic acids with a plentiful liberation of carbonic acid and hydrogen. The nascent hydrogen fixes itself upon the indigo and in presence of alkali converts it into soluble indigo-white. Under certain circumstances the bacillus may, if other matters are wanting, destroy the indigo. He therefore breeds one particular *desmobacterium* which he finds most suitable, and sets his vat in such a manner that the bacillus may be nourished at the expense of the starch, which is gradually converted into glucose and protects the colouring-matter.

Use of the Oil of Winter Green in the Treatment of Acute Rheumatism.—Dr. F. P. Kinnicutt.—A purely medical paper.

Influence of the Temperature of Distillation upon the Composition of Coal Gas.—L. T. Wright.—From the *Journal of the Chemical Society*.

The Deposits of Borocalcite of Maricunga and Pedernal (Chili).—F. Witting.—This mineral contains from 21 to 26 per cent of boric acid. The daily production is 5 to 6 tons of an acid at 90 to 92 per cent.

Vol. xiv., June, 1884.

This number, in addition to the usual abstract of the proceedings of the Academy of Sciences, contains a treatise on the analysis of milk, occupying more than 100 pages.

Justus Liebig's Annalen der Chemie,
Vol. 222, Part 3.

Synthesis by Means of Malonic Ester.—M. Conrad and M. Guthzeit.—(Fourth Treatise). In this memoir the authors discuss dicarboxyl-glutaconic ester and its derivatives.

The Derivatives of Naphthalin.—Icilius Guareschi.—In this very extensive treatise the author examines the dibrom-naphthalins; the action of nitric acid upon dibrom-naphthalin, fusible at 81° to 82°; the behaviour of chromic acid with dibrom-naphthalin; the action of bromine upon nitro-naphthaline; the nitro-brom-naphthalins, and the amido-brom-naphthalins.

Constitution of Thio-aldehyd and Carbo-valeraldine.—Icilius Guareschi.—The author considers the latter compound as a divaleryliden ammonium dithiocarbaminate.

Communications from the Laboratory of the University of Halle.—These comprise a paper on picrotoxine, by Ernst Schmidt, and a memoir on cocculine, by Emil Löwenhardt.

Silicium-Propyl Compounds.—Carl Pape. — The author following the guidance of Wœhler calls attention to the analogy between the carbon compounds and those of silicon. He investigates particularly the silicon-tripropyl compounds.

Vol. 223, Part 1.

Proportion of Crystalline Water of Salts.—Theodor Salzer.—The author arrives at the following generalisations :—(1). When a monobasic acid forms with a metal acid salts, in addition to the neutral salt, the number of the molecules of crystalline water which can be taken up (referred to 1 mol. of acid), decreases with an increasing proportion of acid. (2). When by the union of an acid with a metallic oxide there are formed, in addition to the neutral salt, one or more basic salts, the latter take up less crystalline water than the neutral salt. (3). If a polybasic inorganic acid forms several normal salts with a metal the number of the mols. of crystalline water taken up increases in proportion as the hydroxylic hydrogen is replaced by metal. (4). If a polybasic organic acid forms several normal salts with a metal the number of the mols. of crystalline water taken by these salts increases as the carboxylic or sulphoxylic hydrogen is replaced by the metal. (5). The crystalline salts of the benzol derivatives in which two negative groups such as hydroxyl, carboxyl, sulphoxyl, or nitroyl, bear the ortho relation to each other do not combine with as much crystalline water as the isomeric salts of the para-acids.

On Hipparaffin.—K. Kraut and York Schwartz.—Hipparaffin is an oxidation product of hippuric acid, discovered by H. Schwartz in 1850. The authors regard it as a methylen-dibenzamide.

Capillarity-Constants of Liquids at their Boiling-points.—R. Schiff.—This paper does not admit of abstraction, as the results are given in the form of tables.

Chloride of Lime and Chloride of Lithia.—G. Lunge.—A reply to the criticisms of Kraut (*Annalen*, 221, p. 108 to 124) on the paper of the author, and of Naef (*Annalen*, 219, p. 129).

On Bismuthic Acid.—Dr. C. Hoffmann.—Bismuthic acid, the highest stage of oxidation of bismuth, has the composition Bi_2O_5. Its potassium compounds are formed when bismuth hydroxide is suspended in potassa lye of sp. gr. 1·539, chlorine is introduced in the cold, and after the addition of more potassa-lye the liquid is boiled until it has an alkaline reaction. This process is repeated three times with the bismuth compound obtained, using fresh quantities of the lye. The potassium bismuthates thus obtained are of the general type $2BiO_3K+nBi_2O_5$; they vary from a red-brown to a deep violet brown in colour, and they are richer in potassium the stronger the lye employed. If treated with boiling water they pass into salts poorer in potassium and of a lighter colour. All these compounds are anhydrous. If bismuth hydroxide is suspended in lye so strong that it solidifies on cooling, and treated with chlorine at a boil, yellow and red compounds are obtained in which the bismuth is partly pentavalent and partly trivalent.

Vol. 223, Part 2.

Condensations of Acetone with the Aromatic Aldehyds and with Furfurol.—L. Caissen and A. C. Ponder.—Not adapted for abstraction.

Communications from the Chemical Laboratory of the University of Graz.—These consist of a continuation of a memoir by K. Garzarolli-Thurnlackh, on the action of zinc-ethyl and zinc-methyl upon chlorinised aldehyds, and a paper by K. Garzarolli-Thurnlackh and A. Popper on the action of zinc-propyl and zinc-isobutyl upon butyl-chloral.

Tri-chloro-pheno-malic Acid and the Constitution of Benzol.—A. Kekulé and Otto Strecker.—This paper is essentially a defence of the "benzol-ring." The authors state in conclusion that they are "far removed from asserting that the formation of β-tri-chloro-acetyl-acrylic acid *proves* the truth of the view advanced by one of them concerning the constitution of benzol," but they think it agrees better with this supposition than with any other.

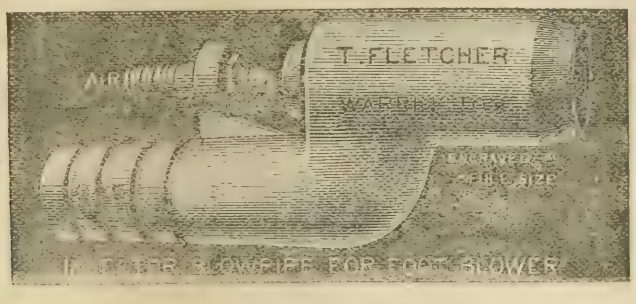
Changes of Volume during Fusion.—R. Schiff.—The author's researches do not confirm the view of Krafft, *i.e*, that a constant difference in composition corresponds to a constant difference in the molecular volumes referred to the melting-point. It appears that the melting-point is not a point of physical comparability, as is the case, in part at least, with the boiling-point.

Cosmos les Mondes.
No. 1, May 3, 1884.

Combination-Heats of the Soluble Compounds of Thallium.—Dr. D. Tommasi.—The author shows that the thermic constant of thallium is exactly equal to the mean of the thermic constants of potassium and lead, with both which metals thallium presents analogies. The thermic constant of manganese is equal to the mean of the thermic constants of iron (ferrosum) and aluminium; that of nickel is equal to the mean of the thermic constants of ferrosum and ferricum.

MISCELLANEOUS.

Powerful Blowpipes adapted for Engineering and Metallurgical Work.—Several new forms of blowpipes have recently been devised by Mr. Fletcher, forming the latest additions to his already long list of ingenious appliances for utilising coal-gas as fuel. One of the neatest forms of these large blowpipes is shown in the accompanying sketch, which explains itself. These blowpipes act as injectors; the one shown in the sketch requires Mr. Fletcher's No. 5 foot-blower, which supplies one-fifth of the necessary volume of air for complete combustion, the remainder being drawn in by the momentum of the air from the blower. At full power it will burn 300 cubic feet of gas per hour, requiring a 1½" main for supply. As an example of what one of these instruments is capable of doing, in one trial, in five minutes from starting, a T-joint was brazed on a 3" wrought-iron pipe. These blowpipes are the largest yet made not worked by power, and as they can be conveniently held in the hand, they are of special value for effecting small repairs in machinery,



without the necessity of pulling down and re-erecting, as well as in metallurgical operations.

MEETINGS FOR THE WEEK

MONDAY, July, 7th.—Royal Institution, 5 p.m. General Monthly Meeting.

FRIDAY, 11th.—Quekett Microscopical Club, 8.

LIVERPOOL UNITED GAS LIGHT COMPANY.

AMMONIACAL LIQUOR.

The Directors of the Liverpool United Gas Light Company are prepared to receive TENDERS for the Ammoniacal Liquor produced at their several works for a term of three years from April 1st, 1885.

The quantities of Ammoniacal Liquor produced per annum are estimated to be as follows, but the same cannot be guaranteed, and may be more or less:—

At the	Athol Street	Works, about	1,400,000	gallons.
,,	Eccles Street	,, ,,	904,000	,,
,,	Caryl Street	,, ,,	1,030,000	,,
,,	Wavertree	,, ,,	1,313,000	,,
,,	Linacre	,, ,,	3,010,000	,,

The Tenders may be for the whole, or for one or more of the works separately.

Forms of Tender and full particulars may be obtained on application to the undersigned.

Tenders sealed and endorsed "Tender for Ammoniacal Liquor," are to be delivered here not later than the 5th day of August next.

The Directors reserve to themselves the right to accept any Tender in part or in whole, and do not bind themselves to accept the highest or any Tender.

WILLIAM KING, Engineer.

Gas Office,
Duke Street, Liverpool,
June 27th, 1884.

LIVERPOOL UNITED GAS LIGHT COMPANY.

TAR.

The Directors of the Liverpool United Gas Light Company are prepared to receive TENDERS for the Tar produced at their several Works for a term of three years from April 1st, 1885.

The quantities of Tar produced per annum are estimated to be as follows, but the same cannot be guaranteed, and may be more or less:—

At the	Athol Street	Works, about	757,000	gallons.
,,	Eccles Street	,, ,,	452,000	,,
,,	Caryl Street	,, ,,	514,000	,,
,,	Wavertree	,, ,,	636,000	,,
,,	Linacre	,, ,,	1,672,000	,,

The Tenders may be for the whole, or for one or more of the Works separately.

Forms of Tender and full particulars may be obtained on application to the undersigned.

Tenders sealed and endorsed "Tender for Tar" are to be delivered here not later than the 5th day of August next.

The Directors reserve to themselves the right to accept any Tender in part or in whole, and do not bind themselves to accept the highest or any Tender.

WILLIAM KING, Engineer.

Gas Office,
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June 27th, 1884.

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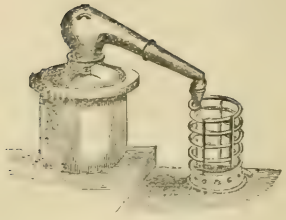
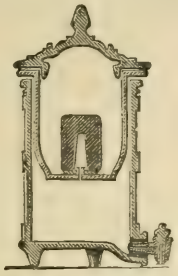
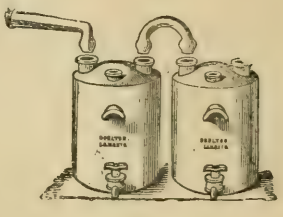


DOULTONS' MANGANOUS



CARBON FILTER.



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London: Printed and Published for the Proprietor by EDWIN JOHN DAVEY, at the Office, Boy Court, Ludgate Hill, E.C. July 4, 1884.

THE CHEMICAL NEWS.

VOL. L. No. 1285.

ON THE HEATS OF FORMATION OF ORGANIC COMPOUNDS CALCULATED INDIRECTLY.

By WILLIAM RAMSAY, Ph.D.,
Professor of Chemistry at University College, Bristol.

THIS note is intended to direct the attention of chemists to a mistake which has, so far as I am aware, uniformly pervaded all calculations of the heats of formation of organic compounds by the indirect method. This mistake, which is, to include the heat of volatilisation of carbon in the heat of formation of organic compounds, pervades the work of Berthelot (see *Comptes Rendus*, 1880, 91, 786), and of J. Thomsen (see *Berichte der Deut. Chem. Ges.*, 1880, 1325 and 1806); and, so far as I know, it is to be found in all other calculations of such constants.

It is customary to ascertain the heats of formation of organic compounds as follows :—The heat absorbed by the decomposition of the compound is justly assumed to be equal to the heat which would be evolved were the elements to combine directly with each other. Now when a compound, say, of carbon and hydrogen is oxidised to carbon dioxide and water, the heat evolved is assumed to differ from that evolved when the same weight of carbon, as diamond or as charcoal, *plus* the same weight of hydrogen are burned, by the heat which would be evolved or absorbed during formation of the compound from its elements. Thus, to take examples from the classical researches of Berthelot and of Thomsen, the heat of formation of dipropargyl is calculated by the former as follows (*loc. cit.*) :—

Dipropargyl, C_6H_6; molecular weight, 78.

72 grms. C (diamond) oxidised to CO_2 = $6\times93,866$ = +563,196 c.

6 grms. H, oxidised to $H_2O = 6\times34,600$ = +207,600

Sum of heats evolved by combstn. of elements +770,796
Heat evolved by combustion of C_6H_6 .. .. +853,600

Difference = heat of formation of C_6H_6 .. − 82,800

These numbers vary somewhat if amorphous carbon be substituted for diamond. The heat of formation is given as −64,800; thus :—

72 grms. C. (amorphous) oxidised to CO_2 = $6\times96,926$ = +581,200 c.

6 grms. H oxidised to $H_2O = 6\times34,600$ = +207,600

Sum of heats evolved by combstn. of elements +788,800
Heat evolved by combustion of C_6H_6 .. .. +853,600

Difference = heat of formation of C_6H_6 .. − 64,800

The heat of formation of benzene is similarly calculated by J. Thomsen. As the method of working is in every respect similar details need not be given.

A list of those who employ a similar method would comprise all those chemists who publish on the subject.

Now the following proof will show the incorrectness of this procedure, and will point to the true method of calculating the heats of formation of organic compounds from gaseous carbon.

The heat of formation of formic acid, CH_2O_2, may be calculated in two separate ways. $CH_2O_2 = 46$.

The reaction is $CH_2O_2 + O = CO_2 + H_2O$.

(1) The hydrogen may be regarded as already oxidised.

26 grms. of CO, oxidised to CO_2 .. .. +68,370 c.
18 grms. H_2O (already formed) 0

Sum of heats evolved by combstn. of elements +68,370
Heat evolved by combustion of CH_2O_2 .. +96,190

Heat of formation of CH_2O_2 from its elements −27,820

(2) The carbon may be regarded as already oxidised.

2 grms. of H, oxidised to H_2O .. .. +68,360 c.
44 grms. of CO_2 (already formed) 0

Sum of heats evolved by combstn. of elements. +68,360
Heat of combustion of CH_2O_2 .. .. .. +96,190

Heat of formation of CH_2O_2 from its elements −27,830

It is evident that both methods give an identical result. It is also to be noticed that H_2, O = CO, O.

Similarly, the heat of formation of acetic acid may be calculated in two ways, $C_2H_4O_2 \times 4O = 2CO_2 + 2H_2O$.

(1) Assuming the hydrogen to be already oxidised.

24 grms. of amorphous C oxidised to CO_2 = $2\times96,960$ = +193,920 c.

36 grms. of H_2O (already formed) 0

Sum of heats evolved by combstn. of elements +193,920
Heat of combustion of $C_2H_4O_2$ (by expt.) .. +210,300

Heat of formation of $C_2H_4O_2$ from its elemnts. − 16,380

(2) Assuming the carbon to be oxidised to CO.

Twice 28 grms. of CO, oxidised to CO_2 = $2\times68,370$ = +136,740 c.

Twice 2 grms. of H, oxidised to H_2O = $2\times68,360$ = +136,720

Sum of heats evolved by combstn. of elements. +273,460
Heat of combustion of $C_2H_4O_2$ (by expt.) .. +210,300

Heat of formation of $C_2H_4O_2$ from its elements + 63,160

In the first case the heat of formation is calculated as −16,380, while by the second method it is +63,160. Now it is evident that the result of the second method is alone correct; and the reason of the discrepancy is also evident, viz., that the heat of combustion of amorphous carbon, or of diamond, includes that required to volatilise the carbon. It would follow that the heat of combustion of carbon supposed to be gaseous to form CO is identical with that evolved when CO burns to CO_2; in fact that (C,O) = (CO,O). For, on re-calculating the heat of formation of acetic acid on this supposition, a result is obtained identical with that of (2). Thus—

(3) Assuming the hydrogen to be already oxidised :—

Twice 12 grms. of carbon (gaseous) to CO_2 = +273,480 c.
Twice 18 grms. of water (already formed) = 0

Sum of heats evolved by combstn. of elements +273,480
Heat of combustion of $C_2H_4O_2$ .. .. .. +210,300

Heat of formation of $C_2H_4O_2$ from its elements + 63,180

From this it follows that the heat of volatilisation of 12 grms. of amorphous carbon at the ordinary temperature is 39,780 c.

It is clear that none but the most misleading results as to the heats of formation are to be obtained from the very numerous observations of the heats of combustion of carbon compounds until this correction has been adopted. The greater part of the numerical results of this branch of thermal chemistry must therefore be re-calculated.

In conclusion, it may be noted that similar instances to that of carbon are known. For just as—

	(C,O) = (CO,O)	= + 68,370 c.,
so	(Sn,O_2)	= +135,360
	(SnO,O)	= + 69,580
	(Cu_2,O_2)	= + 76,580
	(Cu_2O,O)	= + 36,610

In many instances, therefore, union of an element with one atom of oxygen evolves half as much heat as union with two atoms of oxygen.

University College, Bristol,
July 5th, 1884.

ON THE REVERSION OF PHOSPHORIC ACID.

By THOMAS S. GLADDING, A.M.

(Continued from page 3.)

III. *Experiments on Natural Soils.*

The soils used were light loams. One from the truck gardens of Long Island, N.Y., one from the cotton plantations of North Carolina, and one from the tobacco fields of Connecticut, taken from plots upon which fertilisers have been sown and large crops of the before-mentioned staples grown.

The soils were ground to pass through a 20-mesh sieve, and 100 grms. of each were weighed for each experiment.

160 grms. of an ammoniated superphosphate were digested in two litres of water and filtered; the quantity of phosphoric acid found by analysis in 50 c.c. of this filtrate was 0·284 g. This quantity was added to 100 grms. of each soil, prepared as before, and the mixture was stirred to a thin, wet, pasty condition, allowed to remain five days in thin layer exposed to the open atmospheric conditions, in the shade, in open vessels. At the end of this period they were weighed and divided into four equal parts for digestion in citrate of ammonia solution, at temperatures 40° and 65° C., and with water, to determine the amount not reverted.

In order to calculate the exact quantity of reverted dissolved by these digestions, the amount originally in each soil was estimated by previous digestions as follows:—

Soil.	Amount Phos. Acid dissolved from— 25 g. by Citrate of Am. Temp. 40° C.	65° C.	25 g. by Water.
1. Long Island garden..	0·0193	0·0292	trace
2. North Carolina cotton	0·003	0·0076	,,
3. Connecticut tobacco .	0·0072	0·0163	,,

Corrections have been made according to the above results, as follows:—

Soil Experiment 1.—*Long Island Garden Soil.*

25 grms. mixture digested with cold water—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·007	,,
,, ,, reverted..	0·064	,,

25 grms. mixture, digested with citrate of ammonia; temp. 40° C.—

Phos. acid added	0·071	grm.
,, ,, dissolved..	0·0532	,,
Reverted phos. acid dissolved	0·0462	,,

25 grms. mixture, digested with citrate of ammonia; temp. 65° C.

Phos. acid added	0·071	grm.
,, ,, dissolved	0·0702	,,
Reverted phos. acid dissolved	0·0632	,,

Amount of phos. acid added actually reverted 0·064 grm.
Ditto, ditto, and not dissolved at 40° C., .. 0·0178 ,,

Soil Experiment 2.—*North Carolina Cotton Soil.*

25 grms. mixture, digested with cold water—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·0062	,,
,, ,, reverted..	0·0648	,,

25 grms. mixture, digested with citrate of ammonia; temp. 40° C.—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·053	,,
Reverted phos. acid dissolved	0·0468	,,

25 grms. of mixture, digested with citrate of ammonia; temp. 65° C.—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·0713	,,
Reverted phos. acid dissolved	0·0651	,,

Amount of phos. acid added actually reverted, 0·0648 grm.
Ditto, ditto, and not dissolved at 40° C. .. 0·018 ,,

Experiment 3.—*Connecticut Tobacco Soil.*

25 grms. of mixture digested with cold water—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·006	,,
,, ,, reverted	0·065	,,

25 grms. of mixture digested with citrate of ammonia; temp. 40° C.—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·052	,,
Reverted phos. acid dissolved.	0·046	,,

25 grms. of mixture digested with citrate of ammonia; temp. 65° C.—

Phos. acid added	0·071	grm.
,, ,, dissolved	0·0698	,,
Reverted phos. acid dissolved..	0·638	,,

Amount of phos. acid added actually reverted, 0·065 grm.
Ditto, ditto, and not dissolved at 40° C. .. 0·019 ,,

Experiment No. 1 shows that citrate of ammonia solution at temperature of 65° C. dissolves all the phosphoric acid added to the soil, while at temperature of 40° C. it fails to dissolve 27·81 per cent of the phosphoric acid actually reverted by the soil.

Experiment No. 2 shows that citrate of ammonia solution at temperature of 65° C. dissolves all the phosphoric acid added to the soil, while at temperature of 40° C. it fails to dissolve 27·77 per cent of the phosphoric acid actually reverted by the soil.

Experiment No. 3 shows that citrate of ammonia solution at temperature 65° C. dissolves all the phosphoric acid added to the soil, while at temperature of 40° C. it fails to dissolve 29·23 per cent of the phosphoric acid actually reverted by the soil.

In order to obtain a thorough and uniform mixture of the solution of phosphoric acid with so large a volume of soil, the mass was made very wet and stirred; during two days its condition represented very wet lands; later, as more water evaporated, it took upon itself all the successive stages of drought, but at no time contained less moisture than was observed in the fields form the surface to depths varying several inches, during the summer season. Tests made with other portions of these mixtures showed that all the phosphoric acid was dissolved at both temperatures, if kept constantly saturated with water, owing to the ready solubility of all gelatinous precipitates at low temperatures.

Whether phosphoric acid exists in the soil in combination of lime only, or also with iron and alumina, has heretofore never been proven by any direct laboratory tests, because no method of separation was known for distinguishing these three phosphates in the presence of each other in the soil. The results of soil experiments 1, 2, and 3, show that advantage can be taken of this discovery to formulate a method of a laboratory qualitative test for reverted iron and alumina phosphates, under the above conditions. The fact that a strongly alkaline citrate of ammonia solution rapidly attacks insoluble iron and alumina phosphates, but dissolves even less of insoluble lime phosphate than when neutral, constitutes another test for distinguishing these phosphates.

Many investigators have sought a direct proof since the work of Thénard* on this subject, but I am not aware that any has been found.

That phosphoric acid becomes reverted or insoluble in water, when in contact with soil, has been demonstrated by many experiments by such noted scientists as Bronner,† Thompson and Huxtable,‡ Way,‖ Liebig,§ Mulder,¶

* *Comptes Rendus*, 1856, T. 46, p. 212.
† "Treatise" 1836, and *Jahresbericht der ag. Chemie*, 1863—64, S. 6.
‡ *Roy. Ag. Soc. Jour.*, Eng.
‖ *Ibid.*, 1850, vol. xi., p. 313, vol. xv., p. 91.
§ *Annalen der Chemie und Physik*, Bd. 105 and 106,
¶ *Chemie der Akerkrume*, Bd. 1, S. 465.

Knop and Hussakowsky,* Salomon,† Millot,‡ Joulie,‖ and Voelcker,§ and in our own country, by Drs. Johnson¶ and Shephard.**

Of these, a large number believed that it becomes combined largely with iron and alumina. Knop especially proved that phosphoric acid was fixed in greater amount, and more rapidly, when oxides of these bases were *added* to soils; and that soils containing *large quantities* had greater reverting properties than those containing *less* oxides of iron and alumina.

Thénard and Déhérain discussed elaborate theories to establish the chemical reaction by which plants could absorb phosphoric acid from its combinations with iron and alumina; but experience has taught the agriculturist that he cannot reason with certainty regarding these intricate processes.

That plants do absorb phosphoric acid from pure phosphate of iron and alumina by *some means* has been demonstrated beyond a doubt in recent field experiments by Drs. Peterson,†† Voelcker,‡‡ Fittbogen,‖‖ Prof. Dietrich,‖‖ F. Oldenberg,‖‖ Renow,‖‖ Dr. Birner,‖‖ Prof. Maercker,§§ Hoffmeister and others.¶¶

Leaving the theoretical discussion of this question, the practical view of the case is best expressed in the following words from Prof. S. W. Johnson's work, "How Crops Feed," p. 374.

"The great beneficent law regulating these absorptions appears to admit of the following expressions: those bodies which are most rare and precious to the growing plant are by the soil converted into and retained in a condition, not of absolute, but of relative insolubility, and are kept available to the plant by the continual circulation in the soil of the more abundant saline matters."

The quantities of iron and aluminum oxides introduced into the mixtures of artificial soils, with which experiments 2, 3, 4, and 5 were performed, were chosen according to the average amount of these oxides in soils.

Analyses of 87 soils, collected from all the farming districts of New York State by Emmons,*** in 1846, show the average contents of iron oxide and alumina to be 7·79 per cent; of lime, 0·84 per cent.

The average of 20 representative soils, collected in New Jersey by Cook,††† shows, by analysis—Oxide of iron and alumina, 19·33 per cent; lime, 0·77 per cent.

And even in Ohio, where the geological formation is lime rock, the soil contains much more of these oxides than of lime. Average of 13 representative soils show by analysis,‡‡‡ oxide of iron and alumina, 3 per cent; lime, 1·25 per cent.

Very many soils contain less than 0·15 per cent of lime. The normal amount, it is safe to say, does not exceed 0·45 per cent. Lime is rapidly removed from soils by percolating waters. In formations of lime rock, huge caverns are formed by this process; whereas the iron and alumina of the rocks remain in the soils formed from them, with a consequent increase of the relative proportions between these bases and lime.

Knop,‖‖‖ Salomon,§§§ and others have shown that this loss of lime is also largely due to reactions in the soil, by which soluble compounds of lime are formed with nitric, sulphuric, muriatic, and humic acid.

* *Knop's Ag. Chemie.*
‡ *Ibid.*, vol. ii., S. 177.
‡ *Annales Agronomiques*, 1880. *Barrel Jour. d'Agric.*, 1879.
‖ *Comptes Rendus*, 1879, p. 1324.
§ *Roy. Ag. Soc. Jour.*, Eng., 1862, and vol. 1, No. 1, p. 37.
¶ "How Crops Feed," and *Repts. Conn. Ag. Soc.*
** *Rural Carolinian*, June, 1872.
†† *Fühling's Landwirthschafts Zeitung*, 1876, Heft. 5, S. 336.
‡‡ *Roy. Ag. Soc. Jour.*, No. xxxi., 1880. p. 152, No. xxxiii., 1881, and No. xxxiv., 1882.
‖ ‖ *Biedermann's Central Blatt*, March, 1881, and S. 156.
§§ *Ibid.*, June, 1881, S. 378.
¶¶ *Ibid.*, December, 1881, S. 813.
*** "Geol. Rept. New York State," 1846.
††† "Geol. Rept. New Jersey,' 1869.
‡‡‡ "Geol. Rept. Ohio," 1870.
‖ ‖ ‖ *Knop's Ag. Chemie*, vol. ii., S. 177.
§§§ *Ibid.*, vol. ii., S. 177.

Albert and Vollbrecht* experimented on soils containing a large amount of lime, and with others containing a small amount, with the result here given in abstract.

They mixed 10 grms. soil, containing 18 per cent carbonate of lime; 2·5 grms. superphosphate, containing 9·3 per cent phosphoric acid soluble in water, and 12·06 per cent reverted soluble at temperature 40° C. in neutral solution of citrate of ammonia.

Of the total phosphoric acid present, dried in the shade, there became insoluble in water, per cent:—

After Hours.			After Days.				
4.	8.	12.	3.	6.	8.	10.	14.
78	88·4	90·2	91·4	91·7	93·4	93·8	95

There became insoluble in citrate of ammonia, at temp. 40° C.—

2·1	3	4·1	4·1	4·1

Dried in the sun, there became insoluble in water—

97·4	—	100	—	—

In citrate of ammonia at 40° C.—

4·6	—	6·6	—	—

Soil containing small amount of lime mixed with the same superphosphate:—

Of total phosphoric acid present, there became insoluble in citrate of ammonia, at 40° C.—

12.	14.	3.	4.	8.	10.	14.
—	3·1	4·7	5·8	6·5	6·5	6·8

In another experiment they mixed 10 grms. soil rich in lime, 2 grms. superphosphate, containing soluble phosphoric acid 27 per cent, reverted at 40° C, 21·7 per cent:—

Of total phosphoric acid present, there became insoluble in citrate of ammonia, at 40° C.—

	After Days.					
	3.	5.	6.	8.	10.	14.
In the shade..	4·1	5·4	5·4	—	6·8	7·4
In the sun ..	11·1	—	—	15·4	—	—

In another experiment they mixed 10 grms. clay soil 2 grms. superphosphate above used:—

Of total phosphoric acid present, in the shade, there become insoluble in citrate of ammonia, temp. 40° C.—

After 3.	8.	14 Days.
8·2	12·1	—

In another experiment with a sandy soil, same mixture—

Of the total phosphoric acid present, in the shade, there became insoluble in citrate of ammonia, temp. 40°—

4	5·2	7·1

The authors, with Millot and Joulie,† concluded from these experiments that the amount of phos. acid not dissolved by citrate of ammonia solution at 40° C. had become *insoluble phosphate of lime*, and so Déherain thought possibly oxide of iron and alumina produced insoluble phosphates of lime.

Had they digested these soils at the *temperature of* 65° C., *these discrepancies would have disappeared*, as is shown by my experiments on soils 1, 2, and 3 (P).

If all the reverted phos. acid present in these experimental mixtures had been in combination with lime, it would have been entirely re-dissolved at temperature 40° C. by the neutral citrate of ammonia solution, as is proved by experiment No. 1, where lime was the only base present.

Therefore it is impossible to conclude otherwise than that a portion of the phos. acid added was in *combination as reverted phosphates of iron and alumina in these soils.*

Thenard and Deherain in 1858 believed that when even

* *Biedermann's Central-Blatt*, February, 1880, S. 84.
† "Annales Agronomiques," December, 1880.

insoluble phosphate of lime was applied to the soil, eventually the phosphoric acid became combined with iron and alumina, through the chemical agencies of soils.

The physical conditions of oxides of iron and alumina in soils do not seem to affect the principal result of these comparisons of temperature at which citrate of ammonia solution is used; the mineral, brown hematite, used in experiment No. 4, was chosen to represent the mineral oxides of iron formed by decomposition of rocks; though much more active forms of these oxides, such as proto-compounds, are supposed to be present in the chemical changes going on in soils. Bauxite, used in experiment No. 5, represents in the same manner the possible condition of alumina in soils. In short, I do not think that these minerals can be *more active* in their affinities for phosphoric acid than are those contained in soil.

(To be continued.)

ON THE DETERMINATION OF CHROMIUM SESQUIOXIDE.

By M. H. BAUBIGNY.

The tendency of chromium sesquioxide to combine with other bases has caused the separation of chrome in this state to be abandoned whenever the liquid contains any bases other than the alkalies properly so-called. Hence chromium sesquioxide is now separated by being converted into chromic acid. The methods employed for this purpose are fusion with alkalies, alone or mixed with saltpetre, or the action of chlorine or bromine upon the mixture of oxides, suspended in an alkaline lye. Reynoso's permanganate method has been abandoned on account of its serious inconveniences.

Storer, in 1859, proposed the use of the following oxidising mixture:—Chromic oxide, or its salts, whether in the state of powder or of solution, is quickly oxidised at a gentle heat in presence of nitric acid into which potassium chlorate is projected. The conversion into chromic acid is rapid and complete.

This method is absolutely general. Not only is ignited chromic oxide converted almost instantaneously into soluble chromic acid, but even chrome-iron is attacked, and that so thoroughly that the residue, when tested by fusion with sodium carbonate and saltpetre, is found absolutely free from chromium.

When the chrome is once transformed into chromic acid its separation from the other oxides falls under the general case of the separation of acids and bases. When Storer's method has been used the presence of oxy-derivatives of chlorine prevents this operation from being effected by ammonia or its carbonate, unless the chlorous acid has first been expelled by heat, which under certain circumstances is a tedious process.

As examples the author gives the separation of chrome from alumina and from iron. In a concentrated solution of chromium sulphate and aluminium sulphate M. Baubigny transformed the chrome into chromic acid. This process is unattended with danger when conducted in an open vessel, simply covered with an inverted funnel to prevent loss by spirting. The strength of the acid is of little importance in case of soluble compounds, and the heat should not exceed 100°.

When the liquid is cold the alumina is thrown down by a very slight excess of sodium bicarbonate. After standing for an hour or two it is filtered and washed with water very slightly charged with bicarbonate. The alumina which is at first tinted yellow is rapidly decolourised; it is then partially dried and the filter supported by the funnel is kept at the surface of a large volume of water to remove the last traces of alkali. The precipitate is then dried and incinerated as usual.

The chrome is then easily separated as sesquioxide by saturating the bicarbonate with sulphuric acid, adding ammonia, and treating with a current of sulphuretted hydrogen. The reduction is easily and completely effected by raising the mixture to a boil, when it is merely necessary to filter and wash the chromic hydrate. To remove alkalies and alkaline salts the precipitate is dissolved in hydrochloric acid and precipitated by ammonia whilst hot.

The separation of chrome from iron (ferricum) is conducted on the same principles.

If chrome is precipitated as mercurous chromate (Rose's method) the presence of ammoniacal salts must be avoided.—*Bulletin de la Soc. Chimique de Paris.*

DETERMINATION OF MOLYBDENUM AND TUNGSTEN.

By BARON OTTO VON DER PFORDTEN.

I. *Gravimetric Methods for Molybdenum.*

The reduction of molybdic acid to the state of metal is an improvement on the original method of H. Rose. The author has further simplified the methods of Rammelsberg and Debray. He finds that the reduction to metal can be effected in a crucible with a perforated cover, by means of a good gas-blast. He uses a platinum crucible and passes in a current of hydrogen through an earthen tube. In the analysis of ammonium molybdate he heats the sample in the crucible to 170° for some hours in an air-bath, thus avoiding spirting. If the temperature is raised higher, *e.g.*, to 200°, there is a slight loss by sublimation. The crucible is then heated gently in a slow current of hydrogen to superficial reduction. In order to guard against possible loss by sublimation the aperture of the gas-delivery pipe is wrapped in sheet platinum, running to a point below and fitting into the aperture of the lid, with which it is weighed. After the heat has been gradually raised, the complete reduction is effected in the highest heat of a good gas-blast in a strong current of hydrogen. The ignition takes about half an hour for 0·2 grm. of the quantity of metal expected. The reduction is complete when the weight of the crucible is constant, or when the contents take a uniform grey colour. A violet stratum shows that a little oxide is still present; it is then brought to the sides of the crucible by stirring, and the reduction is thus easily completed. The crucible is afterwards to be well cleansed by ignition in the air and by subsequent successive treatments with nitric acid and with ammonia.

This method is applicable for all neutral solutions containing molybdic acid, if combined with precipitation by mercurous nitrate. This process was first recommended by Berzelius for tungsten and was then applied to molybdenum by H. Rose. The cold, concentrated solution of a molybdate, exactly neutralised and freed from carbonic acid, is mixed with an excess of a clear concentrated solution of neutral mercurous nitrate and well stirred up in the beaker with a glass rod. The bulky yellow precipitate clots togeiher and begins to deposit, and if enough of the reagent has been added and the mixture well stirred the liquid quickly becomes clear as water. After a few hours the precipitate may be filtered with the aid of the vacuum pump. Particles which, on stirring, adhere to the sides of the glass are rinsed with hot nitric acid into a platinum crucible and evaporated. The main precipitate, when dry, is separated as completely as possible from the filter and placed in the crucible. The portions adhering to the paper may be rinsed into the crucible with hot nitric acid and evaporated. Or the filter is carefully folded up, so that the particles may be reduced by the carbonaceous matter before molybdic acid can sublime

away, and the whole is incinerated on a platinum wire as nsual. The reduction to metal is then effected as above.

For the analysis of acid solutions containing molybdic acid the reduction of molybdenum trisulphide to the disulphide is recommended as described by Liechti and Kempe. It requires much more time than the reduction to metal and the conclusion of the reduction is not so distinctly marked. The molybdenum disulphide obtained must not be ignited too strongly in the current of hydrogen.

The gravimetric determination of tungsten is much less difficult. The method of Berzelius—precipitation with mercurous nitrate as above described—is convenient and gives good results. Scheele's method,—evaporation of the solution with hydrochloric acid, exactly as for silica—is also to be recommended.

II. *Volumetric Methods.*

Both for molybdenum and tungsten a volumetric process can be founded upon the methods of reduction described above. In both cases complete reduction is necessary in a hydrochloric solution. The molybdenum compounds are titrated in the ordinary manner in presence of air; tungsten, on the other hand, is titrated with exclusion of air.

The execution of the process is substantially the same in both cases. The solution of the salt is mixed, for Mo, with 50 to 60, and for W with 70 to 80 c.c. of hydrochloric acid at 27 per cent. There are then added, for Mo, 8 to 10 grms., and for W 14 to 15 grms. of zinc in the form of rods and in as large pieces as possible; the iron present in the zinc, if any, is previously determined. The solution of the salt may contain 0·3 grm. MoO_3, or 0·1 grm. WO_3. In the latter case the solution is previously heated on the water-bath and the hydrochloric acid and zinc are then added. We thus escape the deposition of tungstic acid in a solid state. The reaction is in both cases brisk, with tungsten even violent, so that there is no occasion to accelerate it by the subsequent application of heat, which, with molybdenum, is sometimes useful towards the end of the process. When the solution of molybdenum has become yellow, and that of tungsten red, the flask is cooled,—in case of tungsten, with especial care.

The remainder of the procedure is different. The reduced solution of molybdenum is rinsed into a porcelain capsule containing about 40 c.c. dilute sulphuric acid and 20 c.c. of a solution of manganous sulphate, free from ferrous salt and containing 200 grms. per litre. The whole is then diluted with an equal volume of water, and at once a considerable number of c.c. of a dilute solution of permanganate are run in with a pipette. It is finally titrated, stirring strongly until a rose colour appears. From the quantity of permanganate consumed is deducted that consumed by the iron present in the zinc and in colouring the water. The solution of permanganate is standardised with potassium dichromate as directed by Volhard. The results are accurate.

$$1 \text{ c.c. } KMnO_4 = 0{\cdot}000752185\ O = 0{\cdot}00451311\ MoO_3.$$

The reduced solution of tungsten is rinsed at once quickly and carefully into a porcelain capsule in which there are an excess of permanganate, 70 to 100 c.c. dilute sulphuric acid, 40 c.c. solution manganous sulphate, but otherwise no water. Not until the flask has been rinsed out is the liquid diluted to 1 litre. In presence of such large quantities of hydrochloric acid the manganous sulphate exerts its power of transferring oxygen only in concentrated solutions. Quick work is essential. Into the liquid which still contains excess of permanganate there is run on an excess of ferrous sulphate, and the solution is finally titrated with permanganate until the rose colouration appears. A volumetric determination is less important for tungsten than for molybdenum.—*Liebig's Annalen.*

CHINESE METALLURGICAL OPERATIONS.

Methods of Refining Gold and Silver.

China has often been spoken of as a sink down which the gold of the world is constantly poured. It is quite a mistake to suppose, however, that all the gold bullion imported by China is retained or consumed in that country; on the contrary, large quantities or gold are re-exported from Hong-kong and various ports of China, in the form of sheet gold or gold leaf, as it is generally called. This form of bullion must not, however, be confounded with the ordinary gold leaf used by gilders, which is very much thinner, and a different article altogether. The thick gold leaf to which we are now referring is manufactured principally for the Indian market, where it goes in payment for the cotton and other commodities imported from that country. Silver is more often cast into small ingots called shoes of sycee, and in this form may be said to be the standard currency of China. In the melting down of gold and silver for leaf gold and sycee of standard fineness, large quantities of crucibles are annually cracked and broken; and we purpose now to give a short description of the various ingenious processes by which the Chinese recover the fragments and minute globules of the precious metals, which, after repeated use, adhere in considerable quantities to these disused crucibles; also to say a few words on the subject of Chinese methods of refining gold and silver and the parting or separating of gold from silver, when the two metals have been melted together in the process of extraction. As the whole of these various manipulations are included in the smelting of the disused crucibles above referred to, it will be sufficient to give an outline of this process.

The goldsmith having accumulated a sufficient quantity of old crucibles to justify him in commencing operations, these crucibles—which are somewhat soft, and manufactured from a but slightly ferruginous, non-siliceous clay, resulting from the disintegration of a felspathic rock, found in the neighbourhood of Fatshan—are first carefully pounded in large iron mortars, then mixed with powdered oxides of lead, of varying and uncertain chemical composition, the result of previous operations. This mixture is then sifted, wetted with water, and puddled and punched in the large iron mortars previously referred to into a kind of a dough, which is worked up by the hand into little conical shaped pellets about 3 inches high by 2 inches in diameter at their base; they are then left to dry in the air under cover. The next process consists in smelting these pellets with the addition of lead; this is done in a small blast-furnace very similar in appearance to those figured in the ancient works of the old European alchemists. The lower or hearth part of the furnace is of a semi-spherical shape, and with the cover, which is made of the clay previously described, strengthened and held together by straps and bands of iron, forms an almost perfect globe, but slightly elongated downwards towards the hearth. The tuyere pipe is of earthenware and is inserted into a hole made through the cover. This pipe does not extend much below the middle of the furnace, and its aperture is thus considerably above the hearth. The furnace itself is about two and a half feet internal diameter by rather more in depth, and the cover is almost exactly semi-spherical. Previously to insertion of the charge the interior portion of the furnace is carefully smoothed and covered with a luting of a kind of black clay made of moulding sand, and a basin, sunk into the floor, opposite the tap hole of the furnace, is similarly prepared for reception of the molten alloy after termination of the process of smelting. The furnace having been prepared for reception of the charge as above described, charcoal in small pieces is inserted to about a foot in depth; then on this is piled the little conical shaped pellets previously described, from which the precious metals are to be extracted; then a layer of lead in small ingots, about seven inches long, flat on one side and semicircular on the other.

Then more charcoal and another layer of lead ingots, and finally the furnace is filled up with charcoal, fire is applied, and the blast urged; the flames and products of combustion escape from an opening in the top of the dome-shaped furnace cover, more fuel being from time to time added as the contents of the furnace become exhausted. When the process is judged to have proceeded sufficiently far—that is when all the little pellets of disused crucible clay are completely melted—the tap hole of the furnace is opened and its contents run out. When the alloy of lead, gold, and silver thus produced has been allowed to cool, it is removed from adherent slag and the next step taken is to oxidise the lead. This is effected in a primitive cupel and muffle furnace constructed as follows. First a quantity of oyster shells are calcined in a suitable furnace by burning with wood, the resulting ash or lime is powdered and sifted; a circular depression in the floor of the furnace room is then filled with this powdered ash, which is carefully rammed down and smoothed, leaving a circular depression or shallow basin-shaped cupel some four inches deep in the centre by two and a half feet in diameter. On this is placed some fragments of charcoal together with the lump of alloy resulting from the smelting operations previously described. The whole is then covered with a shallow basin-shaped cover, like a small segment of a large sphere; this, like the furnace cover, is made of earthenware held together with straps of iron; there are two openings in this cover in order to allow the progress of the operation to be watched, and also a semi-circular opening in its rim for insertion of a tuyere or blast pipe. Fire is then applied to the charcoal on the cupel, the openings in the cover are partially closed, and the whole is covered up with a pile of charcoal. The blast is now urged and the flames or heat from the charcoal on the cupel soon communicate with the heap of charcoal by means of the apertures in the but partially closed cover, between the rim of which and the cupel or hearth a small space is also purposely left. The charcoal on the cupel soon becomes exhausted and is not renewed, the heat being kept up by combustion of the heap of charcoal over the cover. This is one of the most wasteful and least economical metallurgical operations which the Chinese have, as it will be seen that the heap of charcoal being uncovered must radiate the greater portion of its heat into the surrounding atmosphere instead of communicating it to the contents of the cupel. The Chinese operator has a reason for this, however, as he noticed that when a second cover—that is, a cover to the heap of charcoal—was applied, too great a degree of heat was generated and a considerabte proportion of his silver dissipated. There was also considerable difficulty in renewing the fuel and watching the progress of the operation. After a time, varying with the nature of the alloy, the whole, or a greater portion, of the lead is oxidised and absorbed by the ashes of which the cupel is composed; a few fragments of potassium nitrate are then thrown upon the surface of the alloy, in order, as the Chinese workman says, to dissipate the last traces of lead (literally "drive away the breath or spirit of the lead"). The whole is now allowed to cool. The next process is that of parting the gold and silver, which is, for so primitive a people as the Chinese, most remarkably ingenious. The button of alloy from the cupel is placed in a large earthenware crucible and melted in a small blast-furnace or forge, which is not provided with a cover, the smoke, &c., finding exit by means of a hood similar to that over the forges of our own European blacksmiths. When the alloy is thoroughly melted it is kept constantly stirred up with roll brimstone, which acts upon the silver, forming silver sulphide, leaving the gold untouched. The workmen know, by long experience, when the process has gone far enough, and when this is accomplished, the contents of the crucible are poured out into a mould and allowed to cool, the button of gold is knocked off from the mixture of sulphur and silver sulphide, the gold re-melted, and, when wholly fused, a very small quantity of potassium nitrate is thrown upon its surface, and the contents of the crucible, which are now only pure gold and a little potassa, are cast into suitable ingot moulds, and the gold is then, after washing to free it from the potassa, ready for the market.

The mixture of sulphur and silver sulphide resulting from the previous operation is now placed in a large crucible and melted, heat is kept up until the free sulphur is all oxidised or burned away, a suitable proportion of lead is then added to the silver sulphide and kept for some time stirred up with it. This, again, is a very wasteful and unscientific proceeding, but still, considering the authors of the process, remarkably ingenious. The whole is then poured out into a mould, and when cold is placed upon a cupel as previously described, and the original proceeding as for extracting the alloy of gold and silver from the lead of the first operation gone through with, the brightened silver, after cooling, is re-melted, a little nitre thrown upon its surface in the crucible, and the now pure silver cast into ingots for the market.

Considering the complicated nature of these various operations, the quantity of lead lost is very small indeed, the quantity recovered being generally somewhere about two-thirds of the total weight employed in the operation. The lead is recovered by smelting the previously broken up and powdered cupel with its adhering litharge, and other varying oxides of lead, with charcoal in a smelting furnace, similar to that described as employed in the first operation. The resulting slag is a dark reddish or dingy coloured glass, and with the usual Chinese habits of economy where their own property is in question, is turned to account as colouring matter by the makers of artificial stone bangles, snuff phials, and various other ornaments and articles of coloured opaque glass or artificial stone ware. For this purpose the slag in question realises about thirty cents of a Mexican dollar per picul of one hundred and thirty-three and a third pounds. The silver from these operations is cast into shoes of sycee, and the gold beaten into thick leaves or sheets of a standard degree of fineness said to be ninety-eight touch, that is, two parts of alloy to ninety-eight of pure gold. The gold is presumably prepared for the market in this form to prevent the possibility of fraud, in the shape of blocks of base metal being inserted into the centre or interior of ingots ostensibly of pure gold.

The Chinese processes for the assay on the small scale of gold and silver bullion are invariably by cupellation as above described; hence from the volatile nature of silver rendering it easily dissipated by too great heat, the Chinese are almost invariably liable to err in their assays of silver bullion by loss of weight. The Chinese are themselves aware of this fact, and endeavour to correct it by making an allowance for the loss. This, however, is at best but guess work, as the amount of silver volatilised varies with the excess or otherwise of heat to which the alloy in the cupel has been subjected; a practised and skilful operator making perhaps scarcely any appreciable loss, where another in the same operation will volatilise considerably more than the amount which is, by rule, allowed for loss in assay. In their assays of gold, from the greater difficulty with which it can be volatilised, the Chinese are more likely to be accurate, but with gold there are other sources of error, making a Chinese assay at best but an approximation to accuracy.

The Chinese are, however, from long and constant practice, very expert in the use of the touch stone, that is, a piece of dark coloured stone on which they rub the gold and tell by the colour of its streak the degree of fineness; hence the expression, so often heard amongst the Chinese, of so many "touch," pure gold being spoken of as "one hundred touch."

T. I. B.

Hong Kong, 1884.

Examination of Milk.—A. Jörgensen recommends Abbe's refractometer.—*Zeit. f. Anal. Chem.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

DIDYMIUM.

THE atomic weight of didymium has been determined by Marignac, Hermann, Zschiesche, Erk, and Cleve. Mosander's early experiments we may leave out of account.

Marignac† mixed a solution of the sulphate with a slight excess of barium chloride, filtered, weighed the precipitate, and estimated the excess of barium in the filtrate by the ordinary method. The first precipitate always contained didymium, and therefore weighed too much. By deducting the weight of the second precipitate, representing the excess of the barium chloride, from the weight of barium sulphate theoretically formable, the weight of the latter proportional to the quantity of didymium salt taken was found :—

$Di_2(SO_4)_3$.	$BaCl_2$.	1st $BaSO_4$.	2nd $BaSO_4$.
3·633 grms.	3·902 grms.	4·412 grms.	0·084 grm.
3·862 ,,	4·227 ,,	4·679 ,,	0·075 ,,
3·330 ,,	3·552 ,,	4·027 ,,	0·088 ,,
1·386 ,,	1·477 ,,	1·681 ,,	0·014 ,,

These figures give us a ratio between the sulphates of didymium and barium which we may express as follows. Column A gives the $Di_2(SO_4)_3$ proportional to 100 parts of $BaSO_4$, as calculated from the first precipitate of the latter. Column B gives a similar ratio calculated with the second $BaSO_4$ precipitate, this being deduced from the total $BaSO_4$ which the chloride used could form :—

A.	B.
82·344	84·685
82·539	82·626
82·692	85·545
82·451	84·425
82·247—Erk.	
Mean 82·455 ± 0·052	Mean 84·320 ± 0·414

To A I have added a single result of Erk's, to be described further along. It will be seen that although A is theoretically defective, its figures are much more concordant than those in B. In fact, the latter would almost vanish for the final general mean for the atomic weight of didymium :—

From A .. .. .. Di = 143·929
,, B .. .. .. ,, 150·436

In a later paper‡ Marignac adopts two other methods for establishing the atomic weight of didymium. The carefully dehydrated sulphate was taken, the didymium was precipitated as oxalate, and the latter, ignited, yielded oxide. The following percentages of oxide were found :—

58·22
58·24
58·29
58·31
58·29

Mean 58·27 ± 0·0115

The chloride of didymium was also studied. As the anhydrous salt could not be obtained in an absolutely definite state, Marignac prepared neutral solutions of it and determined the ratio between didymium oxide and silver chloride. The latter compound was first precipitated in the usual way, and filtered off : the excess of silver in the filtrate was removed by hydrochloric acid, and after that the didymium was thrown down as oxalate and weighed as oxide. The subjoined weights of AgCl and Di_2O_3 were found. In a third column I give the ratio between the two compounds, putting AgCl at 100 :—

AgCl.	Di_2O_3.	Ratio.
10·058 grms.	3·946 grms.	39·232
5·029 ,,	1·960 ,,	38·974
5·844 ,,	2·276 ,,	38·946

Mean 39·051 ± 0·061

Hence Di = 143·637 ± 0·263.

Hermann's* determination of the atomic weight of didymium rests on a single experiment with the sulphate. By precipitation as oxalate and subsequent ignition, he found that this salt yielded 58·14 per cent of Di_2O_3.

Zschiesche† also analysed didymium sulphate, which he dehydrated at 230°, and afterwards converted into oxide by calcination. I give his percentages, and also, in a fourth column, the percentage of oxide from the *anhydrous* sulphate as deduced from his figures :—

H_2O.	SO_3.	Di_2O_3.	Di_2O_3 in anhyd. salt.
23·19	32·97	43·83	57·070
23·03	32·39	44·58	57·919
23·00	32·56	44·95	58·006
23·547	31·938	44·515	58·225
22·550	32·870	44·570	57·554

The salt used in the first experiment probably contained lanthanum. Rejecting this, the mean of the figures remaining in the fourth column is 57·926 ± 0·094. Hence Di = 141·007.

Erk,‡ to whom reference has already been made, estimated didymium in the sulphate by precipitation as oxalate and calcination to oxide :—

$Di_2(SO_4)_3$.	Di_2O_3.	Per cent. Di_2O_3.
0·556 grm.	0·323 grm.	58·094
0·674 ,,	0·3915 ,,	58·087

Hermann's single result for this percentage, 58·14, agrees more nearly with Erk's series than with any other. It may therefore be averaged in with Erk's two experiments, giving a mean of 58·107 ± 0·0112. Erk also obtained from 0·7065 grm. of sulphate 0·859 grm. $BaSO_4$. This experiment has already been averaged with Marignac's earlier results.

The latest determinations of the atomic weight of didymium were published by Cleve‖ in 1874. Strongly calcined didymium oxide was dissolved in nitric acid, the solution was evaporated with sulphuric acid, and the weight of the resulting sulphate was ascertained. I subjoin the weighings and the percentage of Di_2O_3 in $Di_2(SO_4)_3$:—

Di_2O_3.	$Di_2(SO_4)_3$.	Per cent Di_2O_3.
2·257 grms.	3·844 grms.	58·715
1·086 ,,	1·8485 ,,	58·750
1·1525 ,,	1·9615 ,,	58·756
1·3635 ,,	2·319 ,,	58·797
1·9655 ,,	3·3435 ,,	58·786
1·528 ,,	2·599 ,,	58·792

Mean 58·766 ± 0·0087

Hence Di = 146·804. If SO_3 = 80, Di = 147·021.

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* Smithsonian Miscellaneous Collections. The Constants of Nature."
† *Arch. des Sci. Phys. et Nat.*, (1), 11, 29. 1849.
‡ *Ann. d. Chim. et de Phys.*, (3), 38, 148. 1853.

* *Journ. f. Prakt. Chem.*, 82, 367. 1861.
† *Ibid.*, 107, 74.
‡ *Jenaische's Zeitschrift*, 6, 3 u. 1871.
‖ *K. Svenska. Vet. Akad. Handlingar*, Bd. 2, No. 8. These figures were kindly transcribed for me by Professor Delafontaine of Chicago, as I had not access to a copy of the original memoir.

This determination is undoubtedly the best of all, and might properly be accepted to the exclusion of the others. Still, it is worth while to combine all the figures into one general mean. For the percentage of Di_2O_3 in $Di_2(SO_4)_3$ we have the following data :—

Marignac	58·270	± 0·0115
Erk and Hermann	58·107	0·0112
Zschiesche	57·926	0·094
Cleve	58·766	0·0087
General mean ..	58·451	0·0059

For the atomic weight of didymium we have now three independent values :—

From per cent Di_2O_3 in $Di_2(SO_4)_3$ ..	Di = 144·604	± 0·031
,, Marignac's chloride analyses	,, 143·637	0·263
From Marignac's and Erk's $BaSO_4$ ratio—	Di = 143·929	0·189
General mean ..	,, 144·573	± 0·0306

If O = 16, Di = 144·906.

The following additional note has been communicated by the author :—

Since this chapter was written, Brauner and Cleve have shown the presence of samarium in what were formerly considered pure didymium compounds. By the conversion of purified Di_2O_3 into $Di_2(SO_4)_3$, they arrive at new estimates for the atomic weight of Di. Brauner* in five experiments, finds the sulphate to contain a mean percentage of 58·515 of oxide. Hence Di = 145·26, if SO_3 = 80.

Cleve† gives two series, one of ten and one of seven experiments, the mean percentages being respectively 58·0905 and 58·0895. Hence, in mean, Di = 142·33 if SO_3 = 80. If SO_3 = 79·874, Di = 142·121.

PROCEEDINGS OF SOCIETIES

PHYSICAL SOCIETY.

June 28th, 1884.

Prof. F. Guthrie, President, in the Chair.

New Member :—Mr. W. H. Hensley.

Lord Rayleigh made a communication "*On the Practical Use of the Silver Voltameter for the Measurement of an Electric Current.*" At a former meeting of the Society the method was explained by the author, but on the present occasion the apparatus was exhibited. The author considers this the best method of determining the strength of current in absolute measure. One ampère deposits 4 grms. of silver in an hour, therefore a quarter to half an hour is sufficient to give 1 to 2 grms., quantities which can be measured with accuracy. Any current, from one-tenth to 4 or 5 ampères, can be measured successfully in this way. With very weak currents there is a difficulty in weighing the deposits : with very strong, dense currents the deposit is apt to be irregular. The author deprecates the use of acetate of silver, pure nitrate or pure chlorate giving the best results. The cathode of his apparatus is a platinum bowl; the anode a silver sheet wrapped with clean filter-paper sealed over it to keep any loose silver from dropping on the cathode. The anode is immersed in the solution of silver salt, and at the end of several hours (if great accuracy is required) a measurement of the weight of silver deposited is made by weighing the bowl cathode in a chemical balance.

Dr. Fleming enquired whether it was not better to weigh the loss of weight suffered by the anode, as is sometimes done.

Lord Rayleigh had not found this plan so good, the anode being apt to disintegrate and lose weight not by electrolytic action.

Prof. Guthrie remarked that with small electrodes peroxide of silver is formed, and that the inferiority of acetate of silver might be due to formation of subacetate.

Lord Rayleigh then made a communication on a "*Colour-mixing Apparatus founded on Refraction.*" This apparatus had been described at a former meeting of the British Association, and consists of a double refracting prism, a lens, dispersing prism, and screen, by which an overlapping of spectra can be obtained, and thus a mixture of colours. In comparing different eyesights with it, Lord Rayleigh found that the majority of persons are more sensitive to red than he himself.

In answer to Mr. W. Baily, Lord Rayleigh had not observed any difference between the two eyes of the same person, except what might be due to fatigue and freshness.

Dr. Guthrie enquired if the author had discovered any racial characterics of colour-blindness.

Lord Rayleigh had not observed any so far.

Dr. Guthrie stated that though colour-blind to red, he believed he was more than usually sensitive to blue.

Dr. Stone and Mr. Stanley referred to known cases of blindness to green as well as red.

Dr. Lodge asked if persons abnormally sensitive to red could see further down the spectrum.

Lord Rayleigh believed they could see the spectrum brighter near its limits, at all events.

Mr. Glazebrook briefly described a modification of Lord Rayleigh's apparatus, by which the distance on the spectrum which anyone can see could be measured.

Mr. C. V. Boys read a paper on "*A Phenomenon of Electromagnetic Induction.*" Between the poles of an electromagnet a small disc of copper is hung by a bifilar suspension. If the magnetic field is uniform, and the disc at an angle to the lines of force, then on making the magnet it is jerked parallel with the lines of force. If it is a changing field, and the disc perpendicular to the lines of force, it is repelled on making the magnet, and attracted on breaking by the nearest pole. This phenomenon, which was observed by Faraday, was shown by Mr. Boys to be useful for determining the intensity of a magnetic field by measuring the throw of the disc on magnetising and demagnetising. It might also be employed to measure the resistance of bodies in the form of plates, from their diameter, moment of inertia, and observed throw. Any structural difference of resistance in different directions in the body might be determined by its means. Mr. Boys illustrated his remarks with curves of results obtained by experiment.

Lord Rayleigh considered that the effect of self-induction on the result was not likely to be serious.

Mr. J. Hopps read a paper "*On the Alteration of Electrical Resistance in Metal Wires produced by Coiling and Uncoiling.*" His experiments were made with an inclined plane, the angle of which could be varied, and a car carrying bobbins, which was drawn up or let down the plane by the wires experimented on. It appeared that coiling and uncoiling tends to produce hardness in a wire. Coiling produces an increase of resistance, and uncoiling a decrease in the resistance of a wire.

Mr. R. T. Glazebrook, M.A., F.R.S., read a paper "*On the Determination in Absolute Measure of the Electrical Capacity of a Condenser, and on a Method of Finding by Electrical Observations the Period of a Tuning-Fork.*" The paper described experiments conducted according to a method given in Maxwell (Vol. ii., § 776), for measuring the capacity of a condenser. Mr. J. J. Thomson showed (*Phil. Trans.*, 1883, Part iii.) that Maxwell's formula is only approximate, and gave the correct formula, which was used in the author's experiments. In these tuning-forks were used of frequences approximately 16,

† *Sitzungsb Akad. Wein*, June, 1882.
‡ *Bulletin de la Soc. Chimique*, 39, 289. 1883.

32, 64, and 128 to a second, the frequences being determined by careful comparison with the clock by Lord Rayleigh's method, and the corresponding values found for the capacity were 0·333, 0·3340, 0·3335, and 0·3337 m.f. The mean is 0·3337 m.f., and the experiments do not show any variation in the capacity, as the time of charging varies from $\frac{1}{16}$th to $\frac{1}{128}$th of a second. The condenser was furnished by Messrs. Latimer Clark, Muirhead, and Co. The method also gives a ready and accurate means of determining the pitch of a tuning-fork, for if the capacity of the condenser used is known the frequency (n) can be determined. The author has used the method successfully for this purpose.

Lord Rayleigh objected to mercury contacts in such experiments, and Dr. Stone said he had found iron and mercury contacts good.

Prof. Herbert McLeod exhibited a Sunshine Recorder made by placing a water lens in front of an old camera box. Sensitised paper is placed in the bottom of the box, so that the focussed ray strikes on it, and as the sun moves traces a curved line or band on the paper. Several of these records were shown to the meeting.

The Society adjourned till November 28th.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Meeting, July 7, 1884.

The Hon. Sir Wm. R. Grove, M.A., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

Mr. J. Wimnshurst was elected a Member of the Royal Institution.

Two Candidates for membership were proposed for election.

The Managers at their meeting appointed Professor Arthur Gamgee, M.D., F.R.S., Fullerian Professor of Physiology for three years.

The presents received since the last meeting were laid on the table and the thanks of the Members returned for the same.

ROYAL DUBLIN SOCIETY.

At the June Monthly Meeting of this Society, held at the Society House, Kildare-street, the following papers were read in the Natural Science Section:—

"*On the Possibility of the Formation of Coloured Solar and Lunar Halos, Produced by the Suspension of Volcanic Dust,*" by the Rev. Dr. Haughton, F.R.S. This paper was in connection with the eruption of Krakatoa, in August, 1883.

Prof. C. R. Tichborne read a paper on "*An Argentiferous Galenetic-Blende found in Ovoca.*" The author wished to bring before the notice of the Society a mineral of which very little was known. It had been found in the east district of Ovoca, and was called there "Kilmacooite," from the name of the place where it was found. There can be little doubt that this mineral was identical with one which had been discovered in the Island of Anglesea. No other locality seemed to be known where it had been procured. In Anglesea it was called "Blue Stone."

An analysis performed by the author gave the following results:—

*Silver	0·024
Zinc	25·27
Lead	25·18
Iron	5·51
Manganese	trace
Antimony	0·21
Arsenic	0·08
Copper	2·50
Alumina	0 60
Magnesium, with traces of calcium	0·02
Sulphur	23·71
Silica, &c.	16·896

* Equal to nearly 8 ozs. (troy) per ton.

This mineral may be said, therefore, to consist of—

Sulphide of zinc	37·68
Sulphide of lead	29·07
Sulphide of silver	0·0275

The amount of pyrites varies. The substance does not belong to the mineral proper. It was examined in the spectroscope for the rarer metals, but with a negative result.

The specific gravity is 4·73, and it is harder then blende or galena. The ore is very hard to break, and blasting has to be resorted to to raise it. About 1000 tons can be sighted. It is very homogeneous, forming a close-grained saccharoid mass, but which, from the author's experiments, seems to be an intimate mechanical mixture of microscopic crystals of blende and galena.

Its value consists in the very considerable amount of silver present. In the year 1865 Ireland was supplying about 2½ per cent of the silver raised in the United Kingdom, or 14,000 ounces per annum. It has sadly fallen off since then; therefore the find of this ore should be of some importance.

Mr. S. H. Kinahan read "*Some Notes upon the Recent Earthquake in Essex.*"

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 22, June 2, 1884.

Experimental Researches on the Influence of a Current of Purified Air at Ordinary Temperatures, or at 65°, upon the Fermentation of Saccharine Juices.—M. P. Calliburgès.—The author passed a current of air, freed from all suspended corpuscules, through 30 litres of grape-juice. The fermented liquid obtained, when examined after the lapse of thirteen months, was perfectly clear and free from cotton-like sediment. It contained 18·40 per cent of alcohol by volume.

An Attempt at a Mercurial Galvanometer.—J. Carpentier.—As far back as January, 1881, the author constructed an apparatus similar to that recently presented to the Academy by M. Lippmann, and experimented with it before witnesses.

Spitting of Gold and Silver in the Vapour of Phosphorus.—P. Hautefeuille and A. Perrey.—Whilst endeavouring to reproduce the curious silver phosphides described by Pelletier in 1792, the auihors have been led to study the action of the vapour of phosphorus upon silver and upon gold. In this action there are produced phenomena of the same order as those described by Dumas. Observations have also been made which show more precisely the influence of the change of the physical state of bodies upon the statics of chemical combinations. At the temperature at which it softens silver rapidly absorbs oxygen: at a heat a little below its melting-point it readily absorbs the vapour of phosphorus, at a tension below the atmospheric pressure. Phosphorus renders silver more fusible. At a heat equal to its softening-point, and in a current of an inert gas, silver retains a large proportion of the oxygen absorbed; at the temperature at which the phosphorised silver remains melted it retains a large proportion of the phosphorus absorbed. On solidifying in the air silver abandons a portion of the oxygen taken up: on solidifying in the vapour of phos-

phorus it abandons the whole of the phosphorus. Gold absorbs the vapour of phosphorus at a temperature below its melting-point, retains it at a higher temperature, and spits on cooling. Phosphuretted gold loses its phosphorus at a temperature of 400° to 500°. Most other metals form permanent compounds with phosphorus.

Action of Mercury Sulphide on Potassium Sulphide.—A. Ditte.—This paper does not admit of useful abstraction.

Combination of Gold Chlorides with Phosphorus Chlorides.—L. Lindet.—The author has obtained a double protochloride of gold and phosphorus (Au_2ClPCl_3) and a corresponding per-compound, Au_2Cl_3,PCl_5).

No. 23, June 9, 1884.

Existence of Manganese in Animals and Plants, and its Part in Animal Life.—E. Maumené.—Wheat contains from $\frac{1}{500}$th to $\frac{1}{1500}$th of its weight of metallic manganese. The bulk of the metal exists as the salt of an organic acid. The bran and the starch do not contain any. Rye, rice, and barley contain much manganese. It is also found in potatoes, beets, carrots, lentils, peas, lettuce, parsley, and—in infinitely small traces—in apples and grapes, though the leaves of the vine are tolerably rich in manganese. It is found in a larger proportion in cocoa, in a still larger in coffee, and most of all in tea. In the 50 to 60 grms. of ash obtained from 1 kilo. of tea are found 5 grms. of metallic manganese. On the other hand, manganese is not found in oranges, lemons, garlic, onions, &c. Human blood does not always contain it. Very small traces are found in the milk, the urine, the bones, and the hair. It is almost entirely eliminated in the solid excrements, whence it must be regarded as a mere accidental constituent of the animal system, not essential to life. Medical science must renounce the use of manganese as a substitute for iron. Tea, coffee, and tobacco require an abundance of manganese in the soil.

New Dynamo-electric Machine.—A. Damoiseau and G. Petitpont.—The machine devised by the authors is described as producing about double the work performed by existing machines.

Permeabilify of Silver for Oxygen Gas.—L. Troost.—The author proves that pure oxygen and the oxygen of atmospheric air are capable of passing through the sides of a heated tube of silver, whilst a mere trace of nitrogen penetrated the metal. Carbonic monoxide and dinoxide also permeate silver, though more slowly than does oxygen. The author suggests that pure oxygen may be obtained from the air on this principle. The temperature of the metal must not exceed 800°.

Action of Copper Sulphide upon Manganese Sulphide.—A. Ditte.—A thermo-chemical paper, not capable of useful abstraction.

Solubility of certain Halogenous Salts.—A. Etard.—The author has examined the solubility of sodium bromide and iodide, potassium chloride, bromide, and iodide, and calcium chloride of different temperatures.

Certain Colloidal Substances.—E. Grimaux.—Schweitzer's solution when submitted to dialysis leaves within the porous vessel a body of a colloidal character, which is decomposed by the addition of distilled water, depositing flakes of cupric hydrate. Very minute quantities of magnesium, calcium, aluminium, and copper sulphates, and of very dilute acetic acid precipitate this solution; sodium chloride and potassium sulphate are without action. Copper hydrate is also precipitated by a temperature of 40° to 50°, but the precipitate re-dissolves slowly on cooling. The solution of cellulose in Schweitzer's reagent after three or four days dialysis' loses most of its colour. All the ammoniacal copper nitrite and the excess of water pass into the exterior liquid. The remaining solution of cellulose is less coloured; on the addition of water it gives a gelatinous precipitate which re-dissolves in a few drops of ammonia, forming a perfectly transparent liquid of little colour. The author has also examined the condensed pyruvic ureids, the amido-aspartic colloid, and soluble silica, which he obtains without dialysis by saponifying the methyl silicate of Friedel and Crafts with water.

Synthesis of Pyridic Hydrides.—Oechsner de Coninck.—The author, setting out from β-lutidine and β-collidine, has obtained a small quantity of a dihydro-collidine. By the action of sodium and absolute alcohol upon β-lutidine and β-collidine he has obtained the hexa-hydride of β-lutidine, as a colourless, mobile liquid, differing little in appearance from the pyridic alkaloids.

On Tribenzoyl-mesitylene.—E. Louise.—The author has obtained a new acetone, symmetrical tribenzoyl-trimethyl-benzene. It melts at 215°—216°. It is almost insoluble in cold alcohol, dissolves more readily in boiling alcohol, ether, and benzol, but its best solvent is a mixture of chloroform and acetone.

Crystalline Colchicine.—A Houdès.—Colchicine appears in the form of prisms grouped in colourless mamellæ; it is intensely bitter, turns litmus-paper slightly blue, is sparingly soluble in water, glycerin and ether, but readily in alcohol, benzol, and chloroform. It combines with certain organic acids, but is decomposed by such as act more energetically, and also by the mineral acids. The author proposes to examine how this precipitate differs from that of Oberlin.

Losses of Nitrogen during the Fermentation of Dung.—H. Joulie.—From a series of careful experiments the author finds that a prolonged fermentation of dung involves a loss of nitrogen, which reached 20 per cent in his trial-heaps, but which may be higher in actual practice. This loss is entirely due to the decomposition or the volatilisation of the ammonia contained in the urine, and bears consequently upon the most active and the most easily assimilable portion of the dung heaps. The addition of calcium phosphate does not perceptibly modify the extent of the loss. That calcium carbonate and sulphate, both, largely increase the loss of ammoniacal nitrogen and lessen its fixation upon the organic matters.

Cosmos les Mondes.

No. 2, May 10, 1884.

This issue contains no chemical matter.

No. 3, May 17, 1884.

Existence of Manganese in Wines and in a number of Vegetable and Animal Products.—E. J. Maumené.—Noticed under *Comptes Rendus*.

Alizarin.—An abstract of the history of artificial alizarin.

Formation-Heat of the Soluble Dichromates.—Dr. D. Tommasi.—The combination heat of ammonium dichromate as determined by experiment is 135·0; as calculated, 135·2. The author then gives a table of the calculated heats of a number of soluble dichromates.

No. 4, May 23, 1884.

Non-Existence of Ammonium Hydrate.—Dr. D. Tommasi.—Already noticed.

No. 5, May 31, 1884.

Combination-Heats of Acid Salts.—Dr. D. Tommasi.—The author gives the combination-heats of ammonium sulphate, oxalate, and carbonate, and of the corresponding sodium salts, as found experimentally, and as calculated according to the law of thermic substitution compounds; and a table of the calculated combination-heats for ammonium and sodium tartrates, and hydroxl-ammonium, ethyl-ammonium, and trimethyl-ammonium sulphates, oxalates, carbonates, and tartrates.

THE CHEMICAL NEWS.

VOL. L. No. 1286.

NEW CARBON BATH FOR THE EGGERTZ COLOUR TEST.

By J. OLIVER ARNOLD, F.C.S.

THE Eggertz colour test for estimating carbon in steel is perhaps used more extensively commercially than any other analytical process. This is particularly the case in Bessemer steel works, where every blow is tested to ascertain its percentage of carbon; the number of estimations thus amounts even in a small works to 25 daily.

In carrying out the analytical process, which is too well known to require description, it is of course necessary to preserve the identity of each blow number, and this is effected by dissolving the steels in a square shallow copper water-bath, provided with a lid perforated with holes in which the tubes are inserted in a slanting position, the first hole indicating the starting-point of the day's blows.

This form of bath is objectionable from several points of view:—

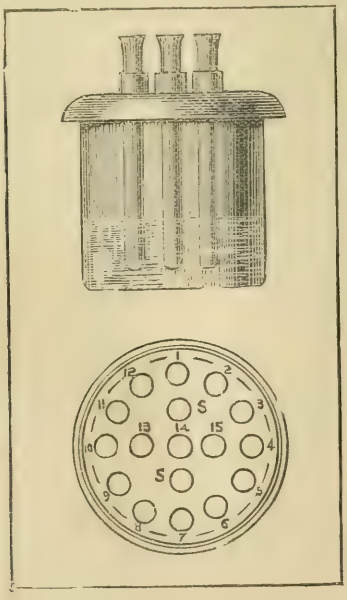
(*a*) It soon gets dirty from the fumes of the laboratory, evaporation of water, and the action of the Bunsen flame.

(*b*) The slanting position of the tubes often causes the solution to dry on their sides.

(*c*) The water in the bath is out of sight, and may easily evaporate to dryness without notice, when the whole batch of carbons would be ruined.

(*d*) The indentity of the tubes may be readily lost by a slip of memory as to how they were originally placed.

(*e*) The bath frequently leaks, and has to be repaired.



The author has consequently designed a bath which two years' constant use has proved to have none of the disadvantages connected with the old form of bath.

The bath consists of a cylinder of glass 5 ins. high by 5 ins. in diameter, closed at one end to contain the water; this is heated on an iron plate or sand-bath nearly to boiling-point (90°—95°). On the top is a perforated cover of glazed white earthenware; this cover contains 17 holes, numbered 1 to 15 in burnt-in black figures, and the other two holes are marked S for the standard steels.

The tubes containing the steels and nitric acid are suspended in the water to the proper depth by slipping on the tube a rather tightly-fitting cylinder of india-rubber ⅜ in. long; this india-rubber serves the double purpose of keeping the ends of the tubes off the bottom of the bath, bumping thus being avoided, and of preventing the bobbing up of the tubes by floatation (see figure).

The apparatus being of glass and glazed earthenware enables it to be washed perfectly clean every day. The tubes are suspended vertically in the water to any desired depth.

The clear numbering enables the selection of any given blow about which "a hastener" has been received without chance of error, and the progress of the solution of the steels in the tubes can be watched without removing them.

Except from mechanical breakage the apparatus is practically indestructible. Wooden covers were tried at first, but were found to be dirty, and to crack in a few weeks from the effect of steaming. In cases where the daily carbons exceed 15, a second and third bath may be employed, the numbering following on, or one large bath could be made; this, however, might prove inconveniently large.

In cases where only a few odd carbons are required a smaller bath perforated for 6 steels and a standard would suffice. The baths used by the author were made to his instructions by Messrs. Cubley and Preston, of Sheffield.

Laboratory,
Sheffield Steel and Iron Works,
Sheffield, July 11, 1884.

ON VITREOUS AND ORDINARY AMORPHOUS SILICA.

By DAVID LINDO.

IT is known that when crystallised silica is fused, it forms a vitreous mass which can be drawn into fine threads; on cooling, it remains transparent, but is no longer crystalline.

In "Watts's Dictionary," 3rd Supplement, experiments made by Monier and Ullik are recorded, which seem to have resulted in the conversion of ordinary gelatinous hydrate of silica into a transparent gelatinous variety. This, on drying and heating, may have resulted in anhydrous vitreous silica, though the behaviour of the bodies described does not quite coincide with this view.

It is said that evaporating an aqueous solution of silica as obtained by Graham's process of dialysis results in the formation of a transparent jelly which dries to a vitreous mass. The existence of anhydrous vitreous silica as a distinct allotropic modification of this body, and the methods of obtaining it, seem, however, to have occupied little attention, the chief aim having been to obtain definite hydrates of silica by drying the jellies at various temperatures.

According to text-books, silica, as obtained in the analysis of silicates, has the aspect of a white earthy powder. If the contents of the dish are stirred when crusts begin to form, and the stirring continued until the mass is dry, the silica will always present the appearance described above to the unaided eye; under the microscope with reflected light it will appear either:—

1st. In the form of amorphous, dead white masses, which in very thin layers are slightly translucent—ordinary amorphous silica.

2nd. As a mass entirely composed of perfectly trans-

parent brilliant particles with sharp edges and angles—vitreous silica.

3rd. As a mixture of these two varieties.

If the melt has been acted on by strong acid without dissolving it first in water, or if very little water has been used to effect solution, the silica will be precipitated in the ordinary gelatinous form, and on evaporating to dryness, with or without stirring, the silica obtained will be ordinary amorphous.

If the melt has been dissolved in a considerable quantity of water, so that on adding the strong acid more of the silica is precipitated, on evaporating to dryness, with or without stirring, all the silica will be obtained in the vitreous form.

If the melt has been dissolved in a moderate quantity of water, so that on adding the acid part of the silica is precipitated and a portion held in solution, the silica on evaporating to dryness will be found partly vitreous and partly ordinary amorphous.

If an acid solution of the melt containing all the silica dissolved is evaporated to dryness without stirring, the silica will form a transparent jelly, and on continuing the heat to dryness, the vitreous silica will be obtained in transparent particles large enough to be visible as such to the unaided eye, having the appearance when washed and dried of coarsely powdered glass. It contains water, which can only be expelled completely by strong ignition.

If a small quantity of ordinary amorphous silica is mixed with a drop of water and examined by transmitted light with the microscope, it will be found to consist of flakes which appear granular and have a yellowish brown colour. Thin layers, without the addition of water, present the same appearance. I have observed this colour with all samples examined, including some prepared by myself with great care, and which I have reason to believe were quite pure.

Vitreous silica examined in the same way appears colourless. Ignited intensely over the blast it appears unaltered, and samples so ignited retain their transparency after being exposed to the air for several weeks. Some samples retained their hygroscopic property in a marked degree after several intense ignitions each of five minutes duration; other samples lost this property completely after the first ignition, gaining nothing in weight though kept under a bell-glass with a vessel of water for several days. I failed to detect impurity by testing, or any difference in appearance by the microscope in those samples that lost their hygroscopic property so readily; yet to the presence of traces of foreign matter I am still inclined to attribute this peculiarity which the samples retained when again ignited.

Vitreous silica formed in the midst of various salts would be more likely to retain traces of impurity than the ordinary amorphous kind. I have seldom succeeded in depriving a sample of the latter of its hygroscopic property by a single ignition over the blast; that is, a sample obtained from the decomposition of water glass.

As regards the very light flaky amorphous silica obtained by passing fluoride of silicon into water, the case may be different. A sample of this tried absorbed no moisture after five minutes' ignition over the blast. On examination under the microscope it was found converted for the most part into transparent particles which may have been crystalline. I have not succeeded by several ignitions over the blast in producing this change in ordinary amorphous silica prepared from water-glass, though probably more intense heat would have done it. Since Jenzsch has shown amorphous silica of sp. gr. 2·6 exists; increase of density is no proof that the amorphous has passed into the crystalline form.

Falmouth, Jamaica, B.W.I.,
June 23, 1884.

The Specific Weight of Paraffin.—E. Sauerlandt.—The specific gravity of the oil ranges from 0·869 to 0·943. —*Zeit. f. Anal. Chem.*

THE ACTION OF THE AIR UPON SOLUTIONS OF TANNIN AND ON THE DETERMINATION OF TANNINS.

By M. ANTONY GUYARD.

It is stated in all the text-boooks that dilute solutions of tannin absorb oxygen from the air, becoming transformed into gallic acid and giving off carbonic acid. We read also that these same solutions are metamorphosed with the same phenomena under the double influence of the contact of air and of ferments, and lastly that the gallic fermentation is effected without the participation of air.

This last assertion seems to be the only true one in conformity with the general laws of fermentation.

The author, in a series of very precise experiments to which unlimited time was devoted, has succeeded in showing that the oxygen of the air has no action upon solutions of tannin.

The apparatus employed consisted of a U-tube with bulbs containing 10 c.c. of a solution of 10 grms. of pure tannin per litre of water.

This tube was connected on one side with a tube filled with pumice moistened with sulphuric acid, and on the other with a Liebig's bulb tube containing a solution of potassa and communicating with three tubes containing solid caustic potassa and calcium chloride. This system of tubes was intended to be weighed, and was arranged in such a manner that neither moisture nor carbonic acid could escape.

This system was connected on the one hand with tubes 1 metre in length and 0·01 metre in diameter filled with solid potassa, calcium chloride, and soda lime, adapted to a large aspirator, and on the other to a similar series of tubes filled with cotton-wool, solid potassa, calcium chloride, and soda lime, communicating with a washing bottle containing a solution of potassa, and intended to deprive it of every trace of water and of carbonic acid.

Whatever was the time employed in these experiments, day and night, and whatever was the volume of air passed into the tannic solution, there was never observed either loss or gain in the system of tubes when weighed; besides it was always impossible to detect the least alteration of the tannic solution or even a sign of gallic transformation.

Solutions of only half the above strength and others two or three times stronger showed the same absolute indifference.

The oxygen of the air, therefore, exerts no action upon dilute solutions of tannin, and the conversion into gallic acid is effected only under the action of atmospheric dust or of ferments, possibly with, but more probably without, the concurrence of oxygen.

In presence of an alkali, purified air acts, on the contrary, with great energy. If we weigh, we may even determine the tannin as M. Terreil does in his apparatus, but the procedure of this chemist is applicable only in limited atmosphere.

By means of the apparatus described above and in presence of an unlimited quantity of purified air, we can cause the alkaline solution of tannin to absorb as much oxygen as we wish, and induce a true combustion of such a nature that the process of M. Terreil, thus modified, is not capable of application to the determination of tannin.

A very useful reagent in the examination of tannins is lead acetate, acidulated with acetic acid. Lead tannate is insoluble in this reagent, whilst lead gallate is perfectly soluble. As gallic acid frequently accompanies tannin, these two bodies may thus be advantageously separated. On afterwards eliminating the lead by means of sulphuric acid and filtering, we have on the one hand a solution of pure tannin, and on the other a solution of gallic acid. Permanganate then serves for the titration of both of these acids when separated.—*Bulletin de la Soc. Chimique de Paris.*

ON THE REVERSION OF PHOSPHORIC ACID.

By THOMAS S. GLADDING, A.M.

(Concluded from page 18.)

Few deposits of mineral phosphates exist free from oxide of iron and alumina. Vast stores of phosphoric acid, provided by nature for agricultural use, are represented by the following names of deposits :—

Commercial Names.*	Per cent contents Oxide Iron and Alumina.
Wicken coprolites	12·00
Cambridgeshire coprolites..	3·25 to 5·25
Bedfordshire ,, ..	8·00 10·00
Ardennes ,, ..	not mentioned
Grand Pré ,, ..	,,
Suffolk ,, ..	4·75 to 10·50
Varennes ,, ..	not mentioned
Bellegarde ,, ..	,,
Boulogne ,, ..	6·00 to 11·50
Bordeaux ,, ..	4 13
German phosphorites	4·5 15
Russian ,, ...	6
Spanish ,, ...	1·25 4
Oruba ,, ...	14·5 26·50
Navassa, red..	10 25
,, lower flat	4 12
Sombrero	4 10
St. Martins	2·75 4·50
Malden Island, Pacific.. ..	1
South Carolina (land)	7

* "Spon's Encyclopædia."

The last is now sold in the market, coloured a pronounced reddish tint by the oxide of iron it contains. It is evident that superphosphates made from such minerals are undervalued when the reverted phosphoric acid is estimated at a temperature of 40° C.; because, as is fair to conclude from experiments 2, 3, 4, and 5, the oxides, dissolved by the sulphuric acid, subsequently combine in the superphosphate with their equivalent of phosphoric acid, and the reverted phosphates of iron and alumina thus formed are *not all dissolved at the temperature* of 40° C., whereas a slight increase in temperature dissolves them entirely, without unduly attacking the *insoluble* mineral, as is proven by my experiments on raw phosphates.

Millot* showed the result of contact of these oxides with soluble phosphates in a superphosphate, prepared from coprolites of the Ardennes. All the phosphoric acid was soluble in water when it was freshly made; but after two years 90 per cent of the phosphoric acid was insoluble in water. Millot washed this with hot water until all the gypsum was removed, and found the residue to be *free from lime*, and to consist of phosphate of iron.

The experiments of Dr. E. Heyden† show how very rapidly and completely reversion takes place under conditions more nearly similar to those when fertilisers are applied to fields. He filtered solutions containing an equal amount of phosphoric acid through four separate soils, 2500 c.c. of the solutions to each 1250 grms. of the soils.

	Amount reverted, Grms.	Amount soluble. Grms.	Per cent not reverted.
Soil A, surface soil (within 8 ins. of surface)	0·137	0·0057	4·16
Soil A, subsoil (between 8 ins. and 16 ins.) ..	0·147	0·0026	1·76
Soil B, surface soil (within 8 ins. of surface)	0·165	0·0053	3·21
Soil B, subsoil (between 8 ins. and 16 ins.	0·153	0·0019	1·24

* *Comptes Rendus*, t. lxxviii, p. 1131; t. lxxxii., p. 522.
† *Annalen der Landwirthschaft*, Bd. 45, s. 189.

Dr. Stohmann* showed by his experiments that from a DILUTE solution of salts, filtered through a given mass of soil, a larger per cent was removed than from a more concentrated solution.

1000 lbs. of superphosphate, containing 100 lbs. of soluble phosphoric acid, sown upon an acre of land, represent a distribution of only 0·0005 grm. to every 26·7 grms. of soil, which is the weight of a mass 1 square inch in surface and 3 inches deep. In the experiments of Heyden, just quoted, 0·150 grm. of phosphoric acid were used to 1250 grms. of soil. Thus, in actual field practice, a solution is employed which, proportionately to the soil, is seven times more dilute than that which Heyden experimented with, and about 120 times more dilute than those used in my experiments.

It is probable, therefore, that the superphosphate becomes reverted *on the spot* where it is sown. If spread broadcast, it lies near the surface; if harrowed or ploughed under, it is brought a few inches deeper.

Liebig† analysed samples of soil at the Experimental Station, at Rothamsted, which had received dressings of superphosphates for twenty-two years in succession, and found three-fourths of the phosphoric acid in the first 9 inches of soil.

It is evident, from the *marked* and *positive* results of the foregoing experiments, that the only *equitable* method of valuation of the *reverted phosphoric acid* of a *superphosphate* must be based upon these facts.

I assert, therefore, that the true method of valuation is that which dissolves reverted phosphates of the same degree of solubility as those which are formed when a soluble superphosphate is mixed with the soil.

That the value of a superphosphate is determined, not alone by its condition in the storehouse, but by its condition within a reasonable time after being sown upon the fields.

That phosphates, soluble in water, become entirely reverted within a few hours, in some cases; in others to the extent of over 90 per cent. This has been shown by my experiments with artificial and natural soils, and there is no lack of testimony by most eminent authorities in verification of these results.

That a superphosphate which was valued by a method in which the temperature was 40° C., if re-analysed by the same temperature, after several days' contact with the soil, after allowing for the amount previously in the soil, would show an apparent loss of 20 to 30 per cent available phosphoric acid, as has actually been shown by experiments 1, 2, and 3.

The following method of analysis of superphosphates recognises the principles demonstrated in this and the previous paper, and contains in addition a detailed manipulation which long experience has fully recommended to our confidence.

Method of Analysis of Superphosphates.

Preparation of Sample.—Pass the sample through a twelve-mesh sieve.‡

Moisture.—Dry 5 or 10 grms. at 100° C.

Total, Phosphoric Acid.—Weigh 2 grms., brush into a 200 c.c. flask, add 50 c.c. nitric acid;‖ boil gently for fifteen minutes, cool and fill to mark, mix, filter through a dry filter-paper into a dry receiver, take 50 c.c. of filtrate, place in a beaker, add 25 c.c. concentrated ammonia, then nitric acid to acidity. To the hot liquid add molybdic solution, let stand for one hour at about 65° C., filter, wash with nitrate of ammonia solution, dissolve on paper with hot ammonia solution, and wash with same. Run in magnesia mixture from a burette at the rate of one drop a second, stirring constantly. Let stand several

* *Henneberg's Jour. f. Landwirthschaft.* 1862. (Translation).
† *Roy. Ag. Soc. Jour.* 1881.
‡ If too wet, a portion of the sample must be air-dried and then sifted, and an allowance made by calculation for loss of moisture.
‖ Several cubic centimetres of HCl must be added here and in solution of the insoluble when working with difficulty soluble iron and alumina phosphates.

hours, filter, wash with ammonia solution, dry, ignite to whiteness, and weigh.

Soluble Phosphoric Acid.—Weigh 2 grms., rub up in a mortar with a soft rubber-tipped pestle,* digest in 25 c.c. of cold water; decant clear liquid on a filter-paper, filtering into a 200 c.c. flask; add 25 c.c. of water to residue, digest for several minutes, and again decant. Repeat for five or six times, and finally bring all upon the filter-paper and wash till flask is filled to the mark; mix, take 50 c.c., and estimate P_2O_5 as in the total.

Insoluble Phosphoric Acid.—Wash the residue upon the paper into a 200 c.c. flask, with 100 c.c. citrate solution, cork the flask with a common cork, digest in a water-bath at constant temperature of 65° C. (150° F.) for thirty minutes. Filter the warm solution quickly† and wash with *cold water*. Return paper and contents to the same 200 c.c. flask, add 50 c.c. nitric acid, boil for fifteen minutes, and estimate the P_2O_5 as in the total.‡

Reverted Phosphoric Acid.—The sum of the soluble and the insoluble phosphoric acid subtracted from the total will give the reverted.

Memoranda.

Citrate Solution.—This is a *neutral* solution of citrate of ammonia of sp. gr. 1·09.

Molybdic Solution.—This is made up as usual to contain 5 per cent. MoO_3. Of this, use 60 c.c. to every 0·100 grm. P_2O_5. (The filtrate should be tested by addition of phosphate of soda to see that an excess of precipitant is employed.)

Magnesia Mixture.—Made up as follows:—

110 grms. crystallised magnesium chloride,
300 ,, ammonium chloride,
400 ,, concentrated ammonia,
1500 ,, water.

Use 10 c.c. to every 0·100 grm. P_2O_5.

(15 c.c. added to 100 c.c. ammonia solution must remain clear after standing twenty-four hours.)

Ammonia Solution.—This consists of 1 part strongest ammonia to 3 parts water.

Nitrate of Ammonia.—This is a 10 per cent nitrate of ammonia solution, slightly acidified with nitric acid.

Laboratory of Stillwell and Gladding,
New York.

A RECALCULATION OF THE ATOMIC WEIGHTS.‖

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

THE YTTRIUM GROUP.

The atomic weights of the metals in this group can only be said to have been determined approximately. Not only do great difficulties attend the purification of the material used for study and the separation of the earths from each other, but there have been and still are grave doubts as to the actual nature of some of the latter. The figures for scandium, yttrium, and ytterbium seem to be tolerably good; those for decipium, philippium, thulium, erbium, and terbium are little more than estimates; for samarium we have no data whatever. All the atomic weights in this group are based upon analyses or syntheses of sulphates; and from analogy to the cerium metals all of these elements are regarded as forming sesquioxides.

Scandium.

Cleve,* who was the first to make accurate experiments on the atomic weight of this metal, obtained the following data. 1·451 grm. of sulphate, ignited, gave 0·5293 grm. of Sc_2O_3. 0·4479 grm. of Sc_2O_3, converted into sulphate, yielded 1·2255 grm. of the latter, which, upon ignition, gave 0·4479 grm. of Sc_2O_3. Hence, for the percentage of Sc_2O_3 in $Sc_2(SO_4)_3$ we have:—

36·478
36·556
36·556

Mean 36·530

Hence, if $SO_3=80$, $Sc=45·044$.

Later and better results are those of Nilson,† who converted scandium oxide into the sulphate. I give in a third column the percentage of oxide in sulphate:—

0·3379 grm.	Sc_2O_3 gave	0·9343 grm.	$Sc_2(SO_4)_3$.	36·166 p.c.
0·3015	,,	0·8330	,,	36·194
0·2998	,,	0·8257	,,	36·187
0·3192	,,	0·8823	,,	36·178

Mean 36·181
± 0·004

Hence $Sc=43·980 \pm 0·015$; or, if $O=16$, then $Sc=44·081$. If $SO_3=80$, then $Sc=44·032$. These values are doubtless very nearly correct.

Yttrium.

For yttrium we need consider only the determinations of Popp, Delafontaine, Bahr and Bunsen, and Cleve.

Popp,‡ evidently worked with material not wholly free from earths of higher molecular weight than yttria. The yttrium sulphate was dehydrated at 200°; the sulphuric acid was then estimated as barium sulphate; and after the excess of barium in the filtrate had been removed, the yttrium was thrown down as oxalate, and ignited to yield oxide. The following are the weights given by Popp:—

Sulphate.	$BaSO_4$.	Yt_2O_3.	H_2O.
1·1805 grm.	1·3145 grm.	0·4742 grm.	0·255 grm.
1·4295 ,,	1·593 ,,	0·5745 ,,	0·308 ,,
0·8455 ,,	0·9407 ,,	0·3392 ,,	0·1825 ,,
1·045 ,,	1·1635 ,,	0·4195 ,,	0·2258 ,,

Eliminating water, these figures give us for the percentages of Yt_2O_3 in $Yt_2(SO_4)_3$ the values in column A. In column B I put the quantities of Yt_2O_3 proportional to 100 parts of $BaSO_4$:—

A.	B.
51·237	36·075
51·226	36·064
51·161	36·058
51·209	36·055
Mean 51·208 ± 0·011	Mean 36·063 ± 0·003

From B, $Yt=101·880$. The values in A will be combined with similar data from other experimenters.

In 1865 Delafontaine‖ published some results obtained from yttrium sulphate, the yttrium being thrown down as oxalate and weighed as oxide. In the fourth column I give the percentages of Yt_2O_3 reckoned from the anhydrous sulphate:—

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* This serves simply to break up lumps. No grinding or trituration of sample is made either in extraction of soluble or reverted phosphoric acid.

† This is best accomplished by use of a filter-pump, or by use of a plaited filter-paper. After the citrate solution has run through, the first paper may advantageously be rolled up, placed upon a second paper, and washed. The use of citrate solution for washing is discarded as being equivalent to a further treatment.

‡ The organic matter from the paper does not interfere in the least with the estimation. We have never found soluble silicic acid in any phosphate in sufficient quantity to give a precipitate and thus interfere with the above method.

‖ Smithsonian Miscellaneous Collections. The Constants of Nature."

* *Comptes Rendus*, 89, 419.
† *Ibid.*, 91, 118.
‡ *Ann. Chem. Pharm.*, 131, 179.
‖ *Ibid.*, 134, 108.

Sulphate.	Yt_2O_3.	H_2O.	Per cent Yt_2O_3.
0·9545 grms.	0·371 grm.	0·216 grm.	50·237
2·485 ,,	0·9585 ,,	0·565 ,,	49·922
2·153 ,,	0·827 ,,	0·4935 ,,	49·834

Mean 49·998 ± 0·081

In another paper* Delafontaine gives the following percentages of Yt_2O_3 in dry sulphate. The mode of estimation was the same as before :—

48·23
48·09
48·37

Mean 48·23 ± 0·055

Bahr and Bunsen,† and likewise Cleve, adopted the method of converting dry yttrium oxide into anhydrous sulphate, and noting the gain in weight. Bahr and Bunsen give us the two following results. I add the usual percentage column :—

Yt_2O_3.	$Yt_2(SO_4)_3$.	Per cent Yt_2O_3.
0·7266 grm.	1·4737 grm.	49·304
0·7856 ,,	1·5956 ,,	49·235

Mean 49·2695 ± 0·0233

Cleve's‡ results are published in a joint memoir by Cleve and Hoeglund, and are as follows :—

Yt_2O_3.	$Yt_2(SO_4)_3$.	Per cent Yt_2O_3.
1·4060 grms.	2·8925 grms.	48·608
1·0930 ,,	2·2515 ,,	48·545
1·4540 ,,	2·9895 ,,	48·637
1·3285 ,,	2·7320 ,,	48·627
2·3500 ,,	4·8330 ,,	48·624
2·5780 ,,	5·3055 ,,	48·591

Mean 46·605 ± 0·0096

This series is unquestionably the best of all. From it, if $SO_3 = 80$, $Yt = 89·485$.

Combining all these data, we have the subjoined general mean for the percentage of Yt_2O_3 :—

Popp	51·208 ±	0·011
Delafontaine, 1st ..	49·998	0·081
,, 2nd ..	48·230	0·055
Bahr and Bunsen ..	49·2695	0·0233
Clève	48·605	0·0096
General mean ..	49·637	0·0069
Rejecting Popp ..	48·705	0·0087

From the general mean of all Yt = 97·616. From the mean, after excluding Popp's work, $Yt = 89·816 \pm 0·067$. Or, if O = 16, Yt = 90·023.

The following additional note has been communicated by the author :—

Since the foregoing re-calculation was first published a later and better series of experiments by Cleve‖ has appeared. The method was the same as before, but the yttria used was wholly free from terbia. In the mean of twelve syntheses the percentage of yttria in the sulphate was found to be 48·503. Hence Yt = 88·9, or, if O = 16, Yt = 89·104. If $SO_3 = 80$, Yt = 89·02.

YTTERBIUM.

For ytterbium we have one very good set of determinations by Nilson.§ The oxide was converted into the sulphate after the usual manner :—

Yb_2O_3.	$Yb_2(SO_4)_3$.	Per cent Yb_2O_3.
1·0063 grms.	1·6186 grms.	62·171
1·0139 ,,	1·6314 ,,	62·149
0·8509 ,,	1·3690 ,,	62·155
0·7371 ,,	1·1861 ,,	62·145
1·0005 ,,	1·6099 ,,	62·147
0·8090 ,,	1·3022 ,,	62·126
1·0059 ,,	1·6189 ,,	62·134

Mean 62·147 ± 0·0036

Hence Yb = 172·761 ± 0·038. If O = 16, then Yb = 173·158. If $SO_3 = 80$, Yb = 173·016. The true number cannot be far from 173.

ERBIUM.

Since the earth which was formerly regarded as the oxide of this metal is now known to be a mixture of two or three different oxides, the older determinations of its molecular weight have little more than historical interest. Nevertheless, the work done by several investigators may properly be cited, since it sheds some light upon certain important problems.

First, Delafontaine's* early investigations may be considered. A sulphate, regarded as erbium sulphate, gave the following data. An oxalate was thrown down from it, which, upon ignition, gave oxide. The percentages in the fourth column refer to the anhydrous sulphate. In the last experiment water was not estimated, and I assume for its water the mean percentage of the four preceding experiments :—

Sulphate.	Er_2O_3.	H_2O.	Per cent Er_2O_3
0·327 grm.	0·353 grm.	0·177 grm.	54·308
1·0485 ,,	0·4475 ,,	0·226 ,,	54·407
0·803 ,,	0·3415 ,,	0·171 ,,	54·035
1·232 ,,	0·523 ,,	0·264 ,,	54·028
1·1505 ,,	0·495 ,,	—	54·760

Mean 54·308 ± 0·0915

Bahr and Bunsen† give a series of results, representing successive purifications of the earth which was studied. The final result, obtained by the conversion of oxide into sulphate, was as follows :—

0·7870 grm. oxide gave 1·2765 grms. sulphate.
61·653 per cent oxide.

Hoeglund,‡ following the method of Bahr and Bunsen, secured these results :—

Er_2O_3.	$Er_2(SO_4)_3$.	Per cent Er_2O_3.
1·8760 grms.	3·0360 grms.	61·792
1·7990 ,,	2·9100 ,,	61·821
2·8410 ,,	4·5935 ,,	61·848
1·2850 ,,	2·0775 ,,	61·853
1·1300 ,,	1·827 ,,	61·850
0·8475 ,,	1·370 ,,	61·861

Mean, 61·8375 ± 0·0063

Humpidge and Burney‖ give data as follows :—

Grms.		Grms.		Per cent.
1·9596	$Er_2(SO_4)_3$ gave	1·2147	Er_2O_3	61·987
1·9011 ,,	,,	1·1781	,,	61·965

Mean, 61·976 ± 0·0074

Combining all four series we get the subjoined general mean for the percentage of oxide in sulphate. In Bahr and Bunsen's single experiment is given the probable error of one experiment in Hoeglund's series :—

* *Arch. des Sci. Phys. et Nat.*, (2), 25, 119. 1866.
† *Ann. Chem. Pharm.*, 137, 21. 1866.
‡ *K. Svenska. Vet. Akad. Handlingar.*, Bd. 1, No. 8.
‖ *Bull. Soc. Chim.*, 39, 120. 1883.
§ *Comptes Rendus*, 91, 56. 1880.

* *Ann. Chem. Pharm.*, 134, 108. 1865.
† *Ibid.*, 137, 21. 1866.
‡ *K. Svenska. Vet. Akad. Handlingar*, Bd. 1, No. 6.
‖ *Journ. Chem. Society*, February, 1879, p. 116.

Delafontaine	54·308	± 0·0915
Bahr and Bunsen	61·653	0·0178
Hoeglund	61·8375	0·0063
Humpidge and Burney..	61·976	0·0074
General mean	61·860	± 0·0046
Rejecting the first ..	61·880	0·0046

From the mean of all, Er = 170·379 ± 0·082; or, if O = 16, Er = 170·770. From Bahr and Bunsen's determination, Er = 168·683; and from Humpidge and Burney's highest, Er = 171·428.

The foregoing data were all published before the composite nature of the supposed erbia was fully recognised. It will be seen, however, that three sets of results were fairly comparable, while Delafontaine evidently studied an earth widely different from that investigated by the others. Since the discovery of ytterbium, some light has been thrown on the matter. The old erbia is a mixture of at least three earths, to one of which, a rose-coloured body, the name of erbia is now restricted. For the atomic weight of the true erbium Cleve* gives three values, but without data concerning weighings or methods. Doubtless the oxide was converted into sulphate, and the calculations were made with $SO_3 = 80$:—

166·00
166·21
166·25

Mean, 166·153

With $SO_3 = 79·874$, this becomes 165·891, and if only O = 16, 166·273. These figures are undoubtedly the nearest yet reached to the true value. According to Thalén,† who reasons from spectroscopic evidence, the erbium of Hoeglund was largely ytterbium.

Samarium.

For samarium we have data by Brauner,‡ and also by Cleve.‖ Brauner, without giving details, says that the atomic weight of samarium may be put at 150·7. Cleve, by his usual method, converts the oxide into the sulphate, and finds the following percentages of Sm_2O_3 in $Sm_2(SO_4)_3$:—

59·180
59·175
59·201
59·190
59·190
59·183

Mean 59·1865

Hence Sm = 149·801; or, if O = 16, Sm = 150·145.

* *Comptes Rendus*, 91, 382.
† *Poggend. Beiblätter*, 5, 122. 1881.
‡ *Journ. Chem. Soc.*, June, 1883.
‖ *Comptes Rendus*, 97, 94.

NOTICES OF BOOKS.

The Blowpipe in Chemistry, Mineralogy, and Geology. Containing all Known Methods of Anhydrous Analysis, many Working Examples, and Instructions for making Apparatus. By Lieut.-Colonel W. A. Ross, R.A. (retired), F.G.S., Member of the German Chemical Society, &c. With 120 Illustrations by the Author. London: Crosby Lockwood and Co.

The improvements which Colonel Ross has effected in blowpipe analysis are not unknown to many of our readers, and are quietly finding their way into general practice both in England and on the Continent. The substance of this work has, it seems, already appeared in the *English Mechanic*. The author has especially adapted his teachings to the intelligent artizans of our cities. He explains carefully the meaning of the technical terms which it is impossible to help employing, and gives instructions to the student how to construct his own apparatus, or, where this is impracticable, where to procure it at the least possible price. He evidently considers, as do the Germans, that Science is best acquired by investigation, and that the use of the blowpipe is one of the easiest and cheapest means of investigation.

With the principle here laid down we fully agree. Actual, careful, patient work is the only method by which any science can be truly acquired. The student who goes conscientiously through the course of experimentation here laid down will gain a better insight into organic chemistry and mineralogy than if he had "got up" any of the best text-books of the day, and passed any number of examinations in their contents.

The author's methods need not be here discussed, as they have been already considered with reference to his two former works, "Pyrology" and "Alphabetical Manual of Blowpipe Analysis." We read, however, with more surprise than satisfaction, the following footnote:—"I understand that 'The City and Guilds of London Institute' have quite recently, by the advice of an irresponsible chemist, cut out blowpipe analysis, as worthless, from their *Curriculum*. It is still untaught at the Royal School of *Mines*." Comment is here surely needless.

From another note we learn that "Berzelius only compiled or edited the first part of the work on the blowpipe which bears his name, the real author being undoubtedly his teacher, Dr. Gahn. It is now well known, also, that Gahn was the real author of the work on the blowpipe attributed to and appropriated by Bergmann."

Experimental Proofs of Chemical Theory for Beginners. By W. Ramsay, Ph.D., Professor of Chemistry in University College, Bristol. London: Macmillan and Co.

It is not easy to give in brief space a correct idea of the nature and object of this little book. The author in it describes a course of experiments forming the preliminary work of all students beginning chemistry in his laboratory. The course consists of the measurement of heat, weighing, experiments on the relation of the volume of the gases to temperature and pressure; the weight of a litre of air; the analysis of air; the determination of the specific gravities of oxygen and of nitrogen, of hydrogen chloride, of watery vapour, and of ammonia.

The chapter on atoms and molecules, in which an account is given of the theories of Dalton, Gay-Lussac, and Avogadro, is ably written. Here, of course, the student encounters much that is not experimentally demonstrable, and of course has to be told that "it is believed." The hypothesis of Sir William Thomson on the shape of atoms and molecules is dismissed as "of little moment to the chemist, who has to deal with changes and with quantities rather than with forms."

The eighth and ninth chapters discuss respectively quantivalence and the equivalents of the metals. Here certain experiments on the determination of equivalents are introduced

The tenth chapter introduces the student to the determination of specific heats, and their employment in ascertaining the atomic weights. We next come to the determination of atomic weights by the aid of replacement. The last chapter discusses the periodic law, with due acknowledgment of the priority of Mr. Newlands.

As to the practical advantages of teaching chemistry, or chemico-physics, on Mr. Ramsay's plan, it might be rash to decide without actual observation. The author thinks that "it is easier to start a number of students in this manner than in the usual course preliminary to qualitative analysis." He also states that "after such a course as this it is easy for a student of ordinary intelligence to acquire a knowledge of qualitative analysis, and it is noteworthy that the detection of unknown substances

is accomplished much more rapidly and accurately after such preliminary training."

Text-Book of Descriptive Mineralogy. By HILARY BAUERMAN, F.G.S. London: Longmans and Co.

WE have here a descriptive treatise on mineralogy, though only the more important species, scientifically or economically speaking, are described in detail.

The subject of nomenclature is considered at some length. The author remarks that "names founded on physical or chemical peculiarities are, as a rule, among the most uncouth and inconvenient, and as they are not unfrequently founded upon false analogies, some trivial character, or one that may be common to many other minerals being selected as a specific distinction, a knowledge of their etymology is not always of advantage as an aid to the memory." Mr. Bauermann holds, very judiciously, that in the case of minerals worked as ores the ordinary commercial names should always be used where possible. "Thus for all purposes copper-pyrites, tinstone, and zinc-blende are preferable to chalcopyrite, cassiterite, and sphalerite."

The author's classification is substantially the same as that followed in the second edition of Rammelsberg's work. The statements of localities are generally on a level with the most recent discoveries. The only mineral of commercial importance which we miss is bauxite, which certainly does not figure in the index. The illustrations, being printed from the blocks used in Brooke and Miller's work, are excellent, and contribute greatly to the value of the work.

Corpulence and its Treatment on Physiological Principles. By Dr. W. EBSTEIN. Translated from the sixth German edition, by Prof. A. H. KEANE, B.A. London: H. Grevel.

SOME time has passed since Banting's pamphlet on the reduction of corpulence moved the comic and the literary papers to laughter. Since then we have had several attempts in the same direction, and a proprietary medicine has even flourished for a time under the title of "anti-fat." Dr. Ebstein, in the treatise before us, aims at combatting the tendency to corpulence in a more rational manner. He distinguishes in the outset between corpulence and obesity, the former state, though inconvenient, being still not incompatible with health, and even with activity, whilst obesity is a formal disease, almost always accompanied by anæmia, and very frequently by gout and diabetes. It is somewhat humiliating to find how observers—professional as well as lay—differ, both as to the causes and the consequences of so common a phenomenon. Some trace corpulence to excess in eating and drinking, or to an injudicious selection of food; others lay the blame on inactivity, on the deficiency of light, on a damp atmosphere, on heredity, &c. There is a similar difference of opinion as to the effects of corpulence upon mental activity. Cantani is quoted as representing the influence of fatness on mental energy as highly injurious, whilst Grisolles and Albert insist that the corpulent have on unsubstantial grounds been taxed with incapacity for intellectual exertion, and J. P. Frank observes that there is no lack of "intelligent fat paunches."

The author raises the question whether corpulence is due simply to fat formed from the food consumed or to self-made fat. He doubts the conclusions drawn by Lebedeff from his dietetic experiments upon dogs, which, receiving linseed oil in their food, deposited in their bodies not ordinary dog-fat, but a substance closely resembling linseed oil. There can, it would seem, be no doubt that stall-fed beasts deposit more fat than they consume *as such*. Hence the excess, at all events, must be formed either from the albuminous compounds or from the carbohydrates. Recent experimentalists find that no fat is formed directly from the carbohydrates, though they cause fat to be separated and deposited from the albumen. The carbohydrates, namely, protect a portion of the albumen from total decomposition, what thus escapes being the fat, so rich in carbon. It appears that a too plentiful consumption of albumen favours the development of corpulence, even when not accompanied by an excessive use of the carbohydrates.

The author divides the possible methods of treatment for corpulence into two great classes, the medical and the dietetic, the latter being subdivided into such as aim at effecting the purpose by a mere change of diet, and such as propose a general alteration in the mode of life.

The strictly medical system is abandoned as at once dangerous and useless. Violent purgatives, diuretics, iodine, caustic potassa, and even vinegar, are no longer prescribed by physicians, though the latter is still employed by silly young ladies who are desirous of looking "delicate."

The change of diet recommended by the author is to be so regulated that no abnormal cravings for food may be experienced, and, though there is a diminution of weight and bulk, no decrease of the power for work must be perceptible.

A striking point in his suggestions is that he does not, like Banting and Cantani, absolutely prescribe the consumption of fats. On the contrary, he reminds us of a fact known already to Hippocrates, that fats reduce the craving for food and for an excess of drink. He excludes, however, the carbohydrates,—sugar, sweets of every kind, potatoes in every form. The daily consumption of bread is limited to 3 to 3½ ounces, and the vegetables allowed are the cabbage tribe, the legumens, spinach, and asparagus.

Although corpulence is less frequently met with in England than was formerly the case,—owing doubtless to the fact that an easy mind becomes more and more a rarity,—this work will be extremely useful not merely to the medical profession, but to those of the general public who have room to dread obesity.

The Extra Pharmacopœia of Unofficial Drugs and Chemical and Pharmaceutical Preparations. By W. MARTINDALE, F.C.S. With References to their Use abstracted from the Medical Journals, and a Therapeutic Index of Diseases and Symptoms. By W. WYNN WESTCOTT, M.B. Lond., Deputy Coroner for Central Middlesex. Third Edition. London: H. K. Lewis.

THE first edition of this little work appeared a year ago. Hence the fact of a third impression having already been found necessary proves that it must meet some distinctly felt want. In fact the rapidity of discovery, in pharmacy no less than in the other applications of chemistry, tends to render pharmacopœias more or less obsolete or imperfect. Hence the necessity for a work like the one before us.

We find here accordingly an alphabetical list of newly introduced remedies, with remarks on their physiological action. Then follows a table of histological preparations used for staining, hardening, and mounting microscope objects. Next comes the index, with a table of doses; and finally a therapeutic index of diseases and symptoms, the remedies for each being arranged alphabetically.

From the form and size of the book we should judge that it is intended as a pocket companion.

The Behaviour of Certain Amidic Acids with Lyes of Potassa and Baryta, and with Magnesia.—E. Bosshard.—The author proves experimentally that if asparagine, leucine, and tyrosine, glutamic acid, &c., are at all attacked by dilute alkalies and alkaline earths, the action is so trifling as not to come in account in ordinary analytical operations.—*Zeit. f. Anal. Chem.*

CORRESPONDENCE.

MEMORIAL TO DUMAS.

To the Editor of the Chemical News.

Sir,—I have received from M. Pasteur, President of the Committee, a letter informing me that it is proposed to erect a statue to the memory of Dumas, at Alais, his native town. The name of Dumas is so prominent in the history of our science that no words of mine are needed in support of such a proposition, and I merely express the hope that many English chemists will be willing to contribute to this memorial. Subscriptions will be received by the Secretaries of the Chemical Society, Burlington House, Piccadilly.—I am, &c.,

W. H. Perkin.

HEAT OF FORMATION OF ORGANIC COMPOUNDS.

To the Editor of the Chemical News.

Sir,—As I am a warm admirer of Prof. Ramsay's experimental work, I may perhaps be permitted to point out the cause of the apparently anomalous results at which he has arrived in calculating the heats of formation of organic compounds. It is a very simple one: the heat of formation of water, $(H_2,O)=68,360$, happens to be equal to the heat of formation of carbonic acid from carbonic oxide, $(CO,O)=68,370$.

Let us examine Dr. Ramsay's calculations:—

The heat of formation of formic acid, *not from its elements*, but from carbonic oxide and water (CO,H_2O), is found to be $-27,820$.

The heat of formation of the same acid *from hydrogen and carbonic acid* is found to be $-27,830$.

That two such different reactions should give out the same amount of heat is no doubt startling; but if E = heat of formation of formic acid from its elements, the first number should be—

$$E-(C,O)-(H_2,O).$$

and the second—

$$E-(C,O)-(CO,O).$$

And since $(CO,O)=(H_2,O)$ these must be equal.

When, however, acetic acid is formed (1) from carbon and water, (2) from carbonic oxide and hydrogen, the numbers are found by Dr. Ramsay, as one would expect, to be different.

If we examine calculation No. 3, and compare it with No. 2, we shall see that it differs only in this, that the heat of formation of 36 grms. of water has been subtracted, and that of 56 grms. of carbonic oxide from "gaseous carbon" put in its place. Now since the latter number is assumed to be equal to the heat of combustion of 56 grms. carbonic oxide, and this is, as we have seen, equal to the heat of formation of 36 grms. of water, it is not altogether surprising that calculations 2 and 3 should give results differing by exactly 20 units.

It is therefore evident that Dr. Ramsay has not as yet found any data which will enable us to say what the heat of volatilisation of carbon really is.—I am, &c.,

H. Forster Morley.

University College, London.

COMMERCIAL ANALYSES.

To the Editor of the Chemical News.

Sir,—May I ask some reader practically versed in the analysis of artificial manures if he can throw any light upon the following matter?

A sample of bone manure the exact value of which it was important to determine was carefully taken, thoroughly mixed, divided into three parts, and sent to three eminent London analysts. Their several analyses as to phosphates and ammonia were as follows:—

Dr. A. ..	Soluble phosphates	21·20
	Insoluble phosphates ..	4·10
	Ammonia	undetd.
Dr. B. ..	Soluble phosphates	24·17
	Insoluble phosphates ..	5·73
	Ammonia	1·69
Dr. C. ..	Soluble phosphates	24·81
	Insoluble phosphates ..	5·52
	Retrograde phosphates ..	5·22
	Ammonia	1·83

Is there any way of accounting for the large discrepancy of the results?—I am, &c.,

F.C.S.

IRON IN CHLOROPHYLL.

To the Editor of the Chemical News.

Sir,—I have to thank Professor H. McLeod, F.R.S. (Chemical News, vol. xlix., page 265), for calling my attention to a mistake which runs throughout my article on this subject (Chemical News, vol. xlix., page 237). On referring to my "Laboratory Notes," what I intended to convey to chemists was, that the alcoholic filtrate was shaken up with its own volume of ether and with about two volumes of water, and *not* "the deposit."

The supplementary note of Dr. Schunck, in the same number of the *Proceedings of the Royal Society*, I had not previously seen before Professor McLeod published his letter, because Dr. Schunck's memoir "On the Constitution of Chlorophyll" was torn out of the *Proceedings* by a scientific friend and sent to me, knowing that I had been working for some time on chlorophyll, and am still continuing these researches.—I am, &c.,

A. B. Griffiths, Ph.D., F.C.S.,
Membre de la Société Chimique de Paris, &c.

The Heath, Bromsgrove, Worcestershire,
July 10, 1884.

SUNSHINE RECORDER.

To the Editor of the Chemical News.

Sir,—In the report of the last meeting of the Physical Society the account of the sunshine recorder I described, but did not exhibit, is inaccurate.

The instrument consists of a camera fixed with its axis parallel to that of the earth, and with the lens northward, and there is placed opposite to the lens a round-bottomed flask silvered inside. The light reflected from the sphere passes through the lens, and acts on the sensitive paper.

I do not know how the idea of the water lens got into the reporter's mind, unless it is because I said that the sensitive paper employed was the ferro-prussiate paper used by engineers, and which is fixed by merely washing with water.—I am &c.,

Herbert McLeod.

Cooper's Hill, July 15, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxiii., Part 2.

Determination of Boric Acid in Boro-silicates.—C. Bodewig.—This paper will be inserted in full.

Detection of Nitric Acid in Presence of other Acids which may mask its Reactions.—Antonio Longi.—The detection of nitrates is often tedious and uncertain when they occur in a complex mixture containing at the same time iodides and bromides, also chlorates, bromates, iodates, chromates, &c. The author proposes the following method:—The solution in question, if acid, is neutralised with sodium carbonate and then treated with sulphurous anhydride until it retains a permanent odour of this gas. When the reduction of the oxy-acids is complete, so that ammonium salts are no longer converted into nitric acid, the liquid is gently heated to expel a portion of the excess of sulphurous acid, and sodium carbonate is gradually added until the reaction is faintly alkaline. On boiling, chrome and other heavy metals are thrown down. The precipitate, if any, is filtered off and the liquid is acidified with acetic acid, filtering again if necessary. The liquid is now mixed with a little acetic acid and pure lead peroxide, and boiled until, on a further addition of the same reagents, vapours which affect starch-paper no longer escape. The liquid is let cool, filtered, the lead in solution is precipitated by means of sodium sulphate, filtered again, and the filtrate is evaporated to dryness on the water-bath. The residue is dissolved in water, filtered if necessary, and tested for nitric acid with the usual reagents.

Simple Method for the Quantitative Determination of Nitric Acid.—Dr. E. Wildt and A. Scheibe.—This memoir cannot be reproduced without the accompanying illustration.

Quantitative Determination of Quartz in Rocks and Soils.—J. Hazard.—The author's method depends on the decomposition of certain silicates when treated with dilute sulphuric acid under strong pressure. Muscovite, biotite, garnet, tourmaline, talc, hornblende, hypersthene, diallage, and pyroxene are completely decomposed. Among the felspars only anorthite and labradorite are dissolved, whilst orthoclase, albite, and oligoclase remain completely unattacked. The author recommends the following procedure: the rock, finely pulverised, is sealed up in a glass-tube with 2 parts of oil of vitriol and 1 part of water, and exposed in an air-bath to a temperature of 250° for six hours. When the tube is opened the contents are rinsed into a capsule, any particles adhering to the sides of the tube being removed, if necessary, by means of a glass rod fitted with a short caoutchouc tube. Before filtering, the acid is suitably diluted. After the residue has been slightly washed, the filter, with its contents, is placed in moderately dilute potassa, digested on the water-bath for an hour; the solution again diluted with water, filtered off, and the residue washed first with dilute potassa, and then with dilute hydrochloric acid. The filter, after being well dried, is incinerated along with its contents in a platinum capsule, and the silica, alumina, and lime are determined in the ordinary manner.

The Qualitative Detection and Quantitative Determination of Arsenic, Sulphur, and Phosphorus, and of Certain Metals occurring in small quantities in the Copper of Commerce.—O. Kuhn.—Reserved for insertion in full.

Modification of Kipp's Sulphuretted Hydrogen Apparatus.—C. Reinhardt.—Requires the accompanying illustration.

Examination of Certain Musts of 1883 for Acid and Sugar.—W. Schæfer.—The nature of this paper appears sufficiently from its title.

Challenge to H. Skalweit.—R. Kissling.—The writer calls upon H. Skalweit, editor of the *Repertorium für Analytische Chemie*, either to substantiate or to withdraw a statement made in that journal touching the determination of nicotine in tobaccos.

Researches on the Detection of Adulterations in Portland Cement.—R. Fresenius and W. Fresenius.—The authors recommend the examination of samples as regards their specific gravity, their loss on ignition, their behaviour with water, and especially the alkalinity of the aqueous solution, their behaviour with dilute acids, with permanganate, and with gaseous carbonic acid.

The Performance of Micro-chemical Operations.—A. Streng.—In observing the results of chemical reactions under the microscope there is often a difficulty in limiting the action of a reagent to some constituent of a rock. Streng uses for this purpose perforated covers of thin glass, which he prepares as follows:—Ordinary covers are plunged in melted wax, and the wax is then scraped off from a spot about ½ to 1 m.m. in diameter. Upon this spot is placed a drop of strong hydrofluoric acid, which is renewed until the glass is corroded through, when the coating of wax is then entirely removed. The part of the thin glass round the aperture is then coated with melted Canada balsam, let cool, and the thin glass is then laid with the balsam side downwards on the section of the mineral in such a manner that the aperture is exactly over the constituent which is to be examined with a reagent. The balsam is then melted by passing a hot knitting needle over the thin glass. When it cools again it forms a boundary round the part to be examined. The reagent is then applied with a pencil, and acts of course only at the exposed spot. As a micro-chemical reagent for soda the author utilises the formation of uranium-sodium acetate. He places a granule of a soda-salt (supposed) upon the port-object and adds a drop of a strong solution of uranium acetate. There are then form around the granule small well-defined pale-yellow tetrahedrons of the double salt.

The Correction of Weighings with Reference to a Vacuum.—J. P. Cooke.—From the CHEMICAL NEWS.

The Determination of the Specific Weights of Gases.—C. Chancel.—From the *Comptes Rendus*.

Determination of the Specific Weights of Gases at High Temperatures.—H. Goldschmidt and V. Meyer.—From the *Berichte der Deutsch. Chem. Gesellschaft*.

Modified Methods for Determining Vapour Densities.—H. Schwarz.—This paper requires the two accompanying figures.

A Simplification of the Dumas Method of Determining Vapour Densities.—B. Pawlewski.—This memoir cannot be reproduced without the accompanying illustration. For the same reason a number of papers on improved thermo-regulators, air- and water-baths, and other apparatus, can merely be mentioned.

Improved Thermo-regulators.—W. T. Richmond, H. B. Wilson, M. Thomas, Lothar Meyer, and H. Vogel.

A Water-Drying Oven.—H. Vogel.

Apparatus for Fractionated Distillation at Reduced Pressure.—L. T. Thorne.

A Boiling Tube for Fractionated Distillation.—C. Winssinger.

Apparatus for Evolving Pure Carbonic Acid.—A. Muencke.

Apparatus for Collecting, Heating, and Weighing Precipitates.—A. A. Breneman.—From the CHEMICAL NEWS.

Platinum Apparatus for Collecting, Weighing, and Burning the Carbon separated from Steel.—Addison B. Clemence.—From the CHEMICAL NEWS.

A Lamp for Heating Tubes.—W. Ramsay.—From the CHEMICAL NEWS.

A Stop-Cock for Store-Bottles.—H. Vogel.—A glass tube, bent at right angles, is fixed with its short horizontal limb in a perforated cork fitting into the tubulure near the bottom of the bottle. If the tube is turned so that the second limb points vertically upwards the bottle is closed, but if it is turned horizontally the liquid runs off.

A Clamp for Holding the Tubes in Determining Melting-Points.—A. Kolliker.

The Use of White Light in Wild's Polaristrobometer.—These two papers require the accompanying illustrations.

A Liquid of High Specific Gravity and Great Refractive Power.—C. Röhrbach.—The author uses a solution of barium-mercury iodide.

The Behaviour of Glycerin with Certain Ethereal Solutions.—C. Mehu.—Glycerin dissolves a number of bodies, *e.g.*, ferric chloride and bromide, gold chloride, uranium nitrate, mercury chloride, and methyl-violet, better than does ether. If the ethereal solutions are shaken up with glycerin, these substances are withdrawn from the ether, though not in all cases to the last trace. The presence of glycerin in a watery solution prevents these substances partially or entirely from being withdrawn on shaking up with water.

The Preparation of Pure Hydrobromic Acid.—W. Grüning.—The author heats 100 grms. of coarsely powdered potassium bromide and 280 grms. phosphoric acid (spec. gr. 1·304) in a flask holding about ½ litre. At first there passes over water, then aqueous acid, and finally pure acid. The yield is about 80 per cent of the calculated quantity.

Preparation of Platinum Chloride.—L. Opificius.—A mixture of ammonium chloro-platinate and metallic platinum is treated with nitro-hydrochloric acid, heating slowly and raising the temperature very gradually to a boil. On evaporating the solution there remains a residue which forms a clear solution with alcohol.

The Cause of the Reddening of Carbolic Acid.—Hager ascribes this phenomenon to the presence of ammonium nitrite in the atmosphere, and Meyke to lead in the glass of the bottles in which it is kept.

Preparation of a Stable Solution of Copper for Determinations of Sugar.—M. Sonnerat.—The author recommends that the solution should be prepared in the cold to avoid the tendency to spontaneous reduction.

Preservation of Standard Solutions of Permanganate.—F. Simond advises that the bottles should be coated externally with black varnish.

Standardising Alkalimetric Solutions and Permanganate.—W. Hampe —The author recommends oxalic anhydride as being easily procured in a state of absolute purity.

The Use of Diphenylamin and Aniline in Qualitative Analysis.—E. Kopp has already used diphenylamin for the detection both of nitric and nitrous acid. C. D. Braun uses aniline for the same purpose. I. According to R. Böttger, aniline is adapted for the detection of chlorates. C. Laar has examined the reaction of chloric acid with diphenylamin and the coloured reactions of other oxidising agents with diphenylamin and aniline. The solution of diphenylamin must be prepared with concentrated sulphuric acid. The strength of the solution of diphenylamin must correspond to that of the chlorate. The experiment is performed either on a larger scale in a wide test-tube, or on the small scale in a watch-glass. In the first case 1 c.c. of the chlorate solution is poured upon about 10 c.c. of the diphenylamin solution. The line of contact takes a fine blue, which, on shaking, spreads through the entire liquid. In the second case about 1 c.c of the diphenylamin solution is placed in the watch-glass and a drop of the solution is cautiously applied by means of a glass rod. In about half a second a radical system of rings of a splendid blue colour spreads over the surface, inclosed in a narrow greenish ring, characteristic of chloric acid as compared with nitric acid, which gives a circle inclosed in a pale blue ring. II. Coloured reactions of other oxidising agents with diphenylamin and aniline. The solutions of diphenylamin and aniline are prepared by dissolving 1 part of the base in 99 parts of the undiluted acid. Hypochlorous acid, bromic and iodic acid, give, with diphenylamin, blue colourations. With aniline hypochlorous acid gives a violet blue; bromic and iodic acid or violet; perchloric acid colours neither of the reagents. Vanadic, chromic, and permanganic acids yield, with diphenylamin, a blue, and with aniline, at first, orange, followed by violet. Molybdic acid gives a faint blue with diphenylamin only. Arsenic, tungstic, and oxalic acids give no reactions. Ferric salts give with diphenylamin a blue colour, passing partly into green, partly into violet. Potassium ferricyanide alone gives with aniline a faint orange, which gradually becomes mixed with violet. Copper, mercury, tin, and platinum salts gave no coloured reactions. With hydrogen and barium peroxides diphenylamin gives a blue, but manganese and lead peroxide a greenish. With aniline, the two former peroxides give no reaction, and the two latter a blue, which appears gradually.

Applications of Hydrogen Peroxide in Analytical Chemistry.—A. Classen and O. Bauer.—Already noticed.

Separation of Gallium from Other Elements.—Lecoq de Boisbaudran.—From the *Comptes Rendus*.

The Absorption-Spectrum of Uranous Salts.—O. Zimmermann.—From *Liebig's Annalen*.

The Establishment of a Method for the Direct Determination of Carbonic Acid in Presence of Alkaline Sulphides, Sulphites, and Hyposulphites.—M. Hönig and E. Zatzek.—The authors have in the first place studied the behaviour of the above-mentioned sulphur compound with permanganate. The alkaline hyposulphites in an acid solution are imperfectly oxidised by permanganate, either in the cold or at a boiling heat. The sulphur acid, poorer in oxygen, which accompanies sulphuric acid is, in the author's opinion, hyposulphuric acid, which alone is not affected by permanganate even at a boiling temperature, and is converted into sulphuric acid only by the free halogens. In a neutral solution the oxidation is more complete, but is still imperfect. In alkaline solutions the hyposulphites are completely converted into sulphates, even in the cold. The alkaline sulphites, in neutral and alkaline, though not in acid solutions, are completely oxidised by permanganate at common temperatures. Alkaline mono- and poly-sulphides are substantially completely peroxidised at a boiling-heat. The authors give the following process for the direct determination of carbonic acid in presence of alkaline sulphides, sulphites, and hyposulphites. The substance in question is placed in a flask holding 300 c.c., and fitted with a caoutchouc stopper having two perforations. Through the one passes a funnel tube, fitted with a cock, and reaching down nearly to the bottom of the flask. Through the other aperture it is connected air-tight with the following pieces of apparatus:—1. A Liebig's bulb-tube, containing a dilute solution of permanganate, slightly acidified. 2. A U-tube, filled with calcium chloride. 3. A Liebig's bulb-tube, filled with potassa-lye (spec. gr. 1·27), and weighed. 4. A U-tube, filled with calcium chloride. After the whole has been joined together, and the connections have been found air-tight, a solution of permanganate containing 5 grms. per litre is allowed to flow down the funnel-tube, shaking occasionally until the solution takes a permanent dark-red. The acid necessary for the decomposition of the carbonate—dilute sulphuric, nitric, or acetic, but never hydrochloric—is next introduced. The cock of the funnel-tube is closed, and the decomposition of the carbonate and expulsion of the carbonic acid are effected by the application of heat, very gently at first, but afterwards raised to a simmer. The heat is then withdrawn, the cock opened, and the funnel-tube placed in connection with a washing-bottle, filled with potash-lye, when air is aspirated through the apparatus for 30 to 45 minutes. The increase of weight in the Liebig's bulb-tube containing potassa gives directly the weight of the carbonic acid. The total sulphur present in the sulphur compounds can be determined in the same portion of the sample. After the determination of the carbonic acid the contents of the decomposition-flask and of the Liebig's bulb-tube containing permanganate, are rinsed into a beaker. The excess of

permanganate is destroyed by the addition of hydrocyloric acid and the application of heat, which at the same time re-dissolves any precipitate. The liquid is boiled to expel chlorine, and the sulphuric acid is determined in the ordinary manner. Of course, only nitric or acetic acid must have been used to decompose the carbonate.

A Reaction for Sulphuretted Hydrogen.—H. Caro and E. Fischer.—The aqueous solution supposed to contain sulphuretted hydrogen is mixed with about 1-50th of its bulk of fuming hydrochloric acid, a few fragments of para-amido-dimethyl-aniline sulphate are added, and as soon as they are dissolved 1 or 2 drops of a dilute solution of ferric chloride. If sulphuretted hydrogen is present the liquid shortly takes a pure blue colour. The reagent may be obtained from commercial helianthine or orange III., which is reduced by grinding it up with 5 parts of water and an excess of ammonium sulphide and heating it on the water-bath. The amido-dimethyl-aniline thus formed is separated from the water by shaking up with ether. The ammonium sulphide taken up by the ether is removed by shaking up with a little lead carbonate made into a paste with water, filtering, and mixing the ether cautiously with an ethereal solution of strong sulphuric acid. The neutral sulphate separates out as a nearly colourless mass. The ether is decanted off and the salt heated on the water-bath with 4 to 5 parts of absolute alcohol until it is converted into fine white needles. These are filtered when cold, washed with alcohol, pressed, and dried on the water-bath.

A Reaction for Gallic Acid.—Sydney Young.—From the CHEMICAL NEWS.

Preparation of Sclerotic Acid.—Valerian Podwissotsky.—The author's process is not stated.

On Coloured Reactions of the Alkaloids.—Karl Hock, and Karl Arnold, and K. Mandelin.—The authors give the reactions of the coloured liquids in a series of tables which do not admit of abridgment.

Spectroscopic Examination of Coloured Ethereal Oils.—Karl Hock.—All the blue oils have the same absorption spectrum and are therefore not capable of being distinguished.

The Composition of Natural Fats.—J. A. Wanklyn and W. Fox.—From the CHEMICAL NEWS.

Action of Bromine upon Cellulose and Starch.—A. P. N. Franchimont.—If moisture is entirely excluded, bromine acts neither upon cellulose nor starch.

Influence of Various Reagents upon the Formation of Sugar.—W. Dettmer.—Carbonic acid and small proportions of citric, phosphoric, and hydrochloric acid, accelerate the formation of sugar, while it is retarded by larger proportions. Small doses of concentrated potassa entirely prevent the formation.

The Solubility of Aniline in the Solution of an Aniline Salt.—A. Lidow.—An aqueous solution of aniline hydrochlorate at 50 per cent dissolves aniline in almost all proportions. Such solutions are sometimes sold as aniline oil, which they much resemble in colour and odour.

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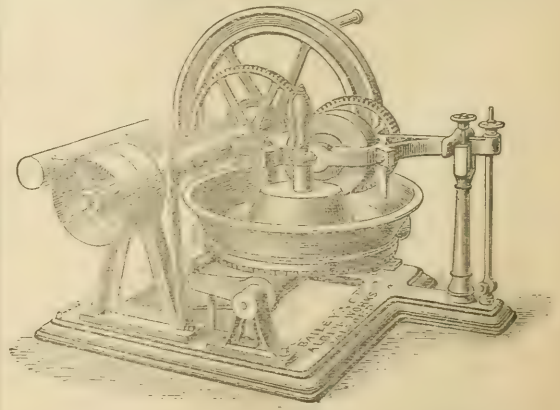

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THE CHEMICAL NEWS.

VOL. L. No. 1287.

CHEMICAL PHENOMENA OF THE RESPIRATION OF PLANTS.

By Dr. T. L. PHIPSON, F.C.S., &c., London.

1. THE experiments on *Protococcus palustris* and other unicellular algæ, published by me last year in the CHEMICAL NEWS (vol. xlviii., p. 205), have been continued, with others made on *Achillea*, *Solanum*, *Veronica*, *Vinca*, *Galium*, and some ferns. What is said here of the chemical phenomena observed with *Protococcus pluvialis*, *P. palustris*, *Mycrocystis minor*, and unicellular algæ generally, applies to the various species of phanerogams belonging to the genera just mentioned, to ferns, and probably to all plants except *Fungi*. On account of the great number of observations made since last year I can only give a very brief and rough account of them here at present.

2. Many years ago I was aware that plants could not decompose CO_2, as was supposed in text-books on vegetable physiology. I had already satisfied myself on this point at Brussels in 1855, when I found that carbonic acid in excess killed the plants, caused them to turn yellow, and that in smaller quantities *alone* it gave rise to no evolution of oxygen in the sunlight.

3. The history of the question may be briefly set down as follows :—More than a hundred years ago Bonnet, of Geneva, discovered that plants in water exposed to sunlight evolved *air*. Dr. Priestley, about 1780, showed that this air was *oxygen*, Ingenhousz then found that daylight or *sunlight* was essential, and Sennèbier showed that *carbonic acid* was no less essential. H. de Saussure found that the phenomena took place in air as well as in water, *i.e.*, that plants absorb CO_2 from the air and evolve oxygen, in fact, converting almost entirely the CO_2 into its own volume of oxygen. Much later still (1845) Professor Boussingault again placed it beyond doubt that it was only in water charged with carbonic acid that plants can evolve oxygen in the sunlight.

4. My experiments go a step further : I have found that *something else* (besides carbonic acid) is necessary, and that carbonic acid *alone* will yield no oxygen in these circumstances.

5. In my last paper in the CHEMICAL NEWS (1883) I showed a simple apparatus by which unicellular algæ, supplied constantly with fresh spring-water and exposed to sunlight, gave a constant evolution of oxygen gas. When the CO_2 of the spring-water is exhausted fresh spring-water is let into the apparatus, whilst the old water is run off, and the evolution of oxygen continues.

6. When the CO_2 of the spring-water was exhausted it seemed natural to supply more CO_2 and not more water. In other words, if *carbonic acid* could be constantly supplied, it appeared that the evolution of oxygen would prove continuous. This was tried: CO_2 was supplied to the water after three or four days' sunning had exhausted its power of causing the algæ to give off oxygen. The faculty of evolving oxygen was certainly restored, but not to any great extent, and it became *less and less manifest with successive additions of carbonic acid*.

7. The spring-water was boiled and then impregnated with pure carbonic acid gas (about 0·10 volume), when it was found that the *Protococcus* gave off *little or no gas at all*. A further quantity of CO_2 was supplied. No result. The experiment was repeated several times, with fresh quantities of spring-water and with other plants. Same results. The conclusion arrived at was that *in spring-water which has been thoroughly boiled for five minutes, then rapidly cooled and supplied, when cold, with small or large quantities of carbonic acid, plants are incapable of evolving oxygen in the sunlight*.

8. It was therefore evident that *something else* is required by the plant, and that this "something else" is destroyed by boiling the spring-water for five minutes. It is *binoxide of hydrogen* that is required. It exists, and its presence can be demonstrated, in all spring-water, and it is as essential to the life of the plant as carbonic acid is. As I hinted in my former paper, the phenomenon generally termed "respiration" of plants is due to the reaction which occurs in the plant-cell between CO_2 and HO_2. (It may be expressed theoretically thus :—

$$CO_2+HO_2=CHO+O_3, \text{ or } CHO_2+O_2, \text{ or } CHO_3+O, \text{ or, again, } 2CO_2+HO_2=C_2HO_3+O_3, \text{ \&c.)}$$

In this manner oxygen is evolved, whilst ternary compounds are formed in the plant-cell.

9. When spring-water is boiled the *air* collected (after absorption of the carbonic acid) contains 30 to 33 per cent of oxygen instead of 21 per cent. This difference is chiefly due to oxygen in the state of *binoxide of hydrogen*. The amount will vary, of course, with different waters and in different circumstances, but probably 6 to 8 per cent of the oxygen yielded by spring-water is in the state of binoxide of hydrogen.

I hope to make known in another paper how binoxide of hydrogen is put in evidence in spring-water, and its quantity approximately ascertained. To-day I must be content with stating that peroxide of manganese (MnO_2) in spring-water exposed to strong sunlight can be made to "breathe" like the unicellular algæ.

10. Unicellular algæ in spring-water which has been impregnated with carbonic acid after boiling (and so deprived of its little charge of HO_2), and having abundant contact with the air, will, after several days' exposure to the sun, evolve slight quantities of oxygen, showing that in these circumstances HO_2 is slowly formed again in the water that has been deprived of it.

11. These observations appear to me to throw quite a new light on the phenomenon of plant respiration, and as the entire growth of the plant depends upon this function, it is probable that in agriculture binoxide of hydrogen will take a higher rank than nitrogen. The science of manuring will consist in providing the soil with materials which by their oxidation will induce the highest possible formation of binoxide of hydrogen and carbonic acid.

12. It is no less evident that these researches will also induce direct experiments in the laboratory with binoxide of hydrogen and carbonic acid, with the view of forming organic substances artificially.*

A GENERAL METHOD OF TOUGHENING GOLD (AND SILVER) IN THE MELTING CRUCIBLE.

By Dr. JAMES C. BOOTH, of the U.S. Mint, Philadelphia.

GOLD and silver differ from other elements, except those of the platinum group, in their feeble affinity for oxygen, and by means of this property we can separate the noble metals from others by fusion in the fire, in which heat removes oxygen from gold and silver and attaches it to the others. To this first class we may add a second, embracing iron, nickel, copper, tin, bismuth, and lead, whose oxides may be reduced to metal by being heated with fuel, or without reduction can be melted with fluxes or slag. A third class, arsenic, antimony, and sulphur, are reduced and volatilised, or are fluxed off with alkali and oxides of the second glass.

To illustrate the subject practically, I shall describe an operation of toughening brittle gold which I recently per-

* I have expressly avoided any allusion to *temperature* in the above though it plays quite as important a part as *light* in the phenomena under consideration; but I reserve my observations on this subject for another time.

formed at the United States Mint at Philadelphia. Some brittle gold, having been accidentally melted with a quantity of well-refined and tough gold, was found to have rendered the whole mass very brittle, with a highly crystalline fracture, and therefore useless for coinage. I determined to avoid loss of time, and the greater cost of refining by acid, and to toughen it wholly by fluxing. This was accomplished on 75,162$\frac{5}{100}$ ounces (=5154 lbs. av.) in 1½ days, at a trifling cost, and with scarcely apparent loss. The 75,000 ozs. were divided into 14 melts of about 5400 ozs. each, and each melt separately toughened. The ingots, easily broken into pieces by striking them on the edge of a wooden box, were put into the crucible with soda-ash and anhydrous, fused borax, in the ratio of one or two ounces to a melt until the crucible was nearly full. It then appeared as a quiet mass of metal covered with a rather viscid slag, disposed to swell and puff. A few crystals of saltpetre, say one or two ounces, were then dropped successively into the centre of the metallic surface, and as they melted, their spreading out over the whole surface was aided by the concentric motion of the bottom of a small crucible. The moment the visible oxidising action began to slacken, the melter skimmed off, by a small black-lead dipping crucible, the fluxed matter as rapidly as was consistent with the care necessary to avoid taking up metal. The remainder in the melting-pot was the toughened metal.

There are several points worth noting in the operations just described. 1. One part of the foreign matter was sufficient to impart brittleness to 75,000 parts of good standard gold (st. gold=900 gold + 100 copper, &c.). 2. By a slight oxidising process the matter causing brittleness was collected and removed at a trifling cost in 1½ days, without appreciable loss of gold. 3. Still more remarkable is the fact that the 14 melts of gold, in their brittle state, proved by assay to be of true standard, 900 gold+100 alloy (usually 90 copper + 10 silver), after their brittleness had been changed to toughness by fluxing and skimming, were still 900 gold + 100 alloy inappreciably altered. So delicately executed is the act of toughening, that although 10 per cent of the metal is easily oxidised copper, yet the ratio of copper after fluxing is the same. 4. Another point worthy of remark is that the toughening proceeds from the top downward, to the depth of 9 to 12 inches of its own accord, although it is stirred towards the close of the operation to render the melt uniform throughout.

I do not wish the inference to be drawn that every case of toughening brittle gold is as successful or simple as the above. When the metal contains a larger proportion of foreign matter, the operation of fluxing, nitreing, and skimming may have to be repeated, perhaps more than once. While the crucible is on the fire, the perfection of the toughening may be readily ascertained in 2 or 3 minutes by casting a thin strip, ¼ to ⅛ inch thick, and doubling it under the hammer or rolling it, the cracking of the strip in this case, if any, or its snapping asunder, informing the experienced eye of the degree of completeness in the toughening operation.

When the bullion appears to be baser—to contain a larger amount of foreign matter than in the example specially quoted in this paper, and experience can often make an approximate guess at the degree of baseness as well as at the nature of the elements causing it, then the only change made in the toughening consists in using a larger amount of soda and borax, and a still larger proportion of nitre. Two points are to be noted in the use of a large amount of this more oxidising flux:—1. That some of the graphite of the crucible at the level of the liquid is cut away, injuring the crucible and weakening the oxidising power of the nitre. 2. That since the larger bulk of fluxing matter increases the time of skimming, some of the oxidised foreign matter, in the presence of a large amount of metal, and surrounded by graphite, tends to revert to the metallic state.

To obviate these difficulties or objectionable features, after going through the stronger oxidising process, as above described, the oxidation is suddenly fixed by the rapid addition to the floating slag of sand, lime, or bone-ash, which is stirred with the slag and thickens or stiffens it, so as to allow more deliberate skimming of the whole mass without fear of re-oxidisation. I have tried the three thickeners above named, which seem to act rather mechanically than chemically, and, of the three, prefer sand. Where thickeners are employed on standard gold, there is greater liability to an increase in fineness of the standard by the removal of oxide of copper, together with the oxidised embrittler, so that brittle gold of 900 after toughening may be 900·5 or even 901.

The toughening of the above 75,000 ozs. effected in fourteen meltings (fourteen crucibles full) of over 5000 ozs. each in standard gold, resulted in less than a crucible full of skimmings. The skimmings are worked down to metal and poor slag as follows. They are quietly melted and cooled slowly, so as to form a *king* of metal at the bottom of the crucible, and a glassy or cindery slag above. The last is ground and separated by sifting and washing into metallic grains and poor cinder. The grain and king are again fluxed and treated as before, either by themselves or as usual with other light residues. Thus the impurities of gold (and silver) are successively worked out, by concentrating them in a small bulk and weight of metal, and purifying it with a greater diminished risk of loss of gold than if we attempted to purify a large mass at one operation. In the case detailed in this paper the impurities were concentrated by a single operation of purifying in a king of about (8) eight ozs. From the purification of this king, we have ground for asserting that the impurity causing brittleness in the whole 75,000 ozs. was a small fraction of an ounce, probably $\frac{1}{300000}$ or less, of the original weight.

As a concluding note to this paper, I must state that a great deal of skill is required to avoid loss of gold in executing the process herein detailed; that the melter must have unusual powers of observation and long practice to acquire the necessary skill, and I deem it but justice to state that Mr. F. C. Garrigues, my foreman, especially in the melting department of the Mint, possesses the requisite skill and practice, and that he performed the operations above described.—*Journal of the American Chemical Society.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JUNE 30TH, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, July 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from June 2nd to June 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to

oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

The results set forth in these several Tables, taken together, show that the June supply of water to the Metropolis has differed but little in character from the supplies of the preceding months.

During the past six months we have examined 1071 samples of water drawn from the mains of the seven companies taking their supply from the Thames and the Lea, and have been able to register these many samples as being, without a single exception, clear, bright, and efficiently filtered. Judged by the eye, they had all of them the further claim to be described as being, even when in considerable bulk, colourless. Subjected to more exact examination in this particular, their degree of brownish tint proved to be exceedingly low, so as in no case to preponderate over the proper blue tint of the water. According to the scale adopted by ourselves, based on a comparison of the tint of the water with the tints of certain brown and blue mineral solutions of definite strength, the mean ratios of brown to blue tint observed in the Metropolitan supply during the past six months were as 15·3 to 20 in January, as 12·8 to 20 in February, as 9·5 to 20 in March, as 6·7 to 20 in April, as 8·5 to 20 in May, and as 13·1 to 20 in June. The whole of the 1071 samples were further examined for organic matter by the permanganate process, and for dissolved oxygen by the Schutzenberger process, with similarly satisfactory results.

Of the 148 samples of water submitted to complete analysis—or one sample daily, exclusive of Sundays and holidays—42 samples were furnished by the New River and East London Companies, in chief measure from the Lea; while the remaining 106 samples were furnished by the five Companies taking their supply from the Thames. As regards the quantities of organic carbon, and consequently of organic matter present in these Thames-derived samples, the mean result for January, exceptionally low for this season of the year, was 0·118 part of organic carbon in 100,000 parts of water. The mean result for February was 0·140 part, for March 0·165 part, for April 0·139 part, for May 0·104 part, and for June 0·114 part of organic carbon in 100,000 parts of the water; while the highest result furnished by any single sample examined during the last two months was 0·129 part, equivalent to about a quarter of a grain of organic matter per gallon.

It was explained in the Report of the Royal Commission on Water Supply, that a minute proportion of organic matter, variable in amount with season, is a normal constituent of river water; that there is no reason whatever to consider this proportion of natural organic matter as in any way prejudicial to health; and that there is absolutely no chemical evidence to indicate that the small proportion of organic matter present in the water supply of London is different, either in quantity or kind, from the natural organic matter of the river, as met with for instance at Lechlade, 120 miles above the intake of the Companies. Still, in view of the importance which is sometimes attached, though as we maintain unwarrantably, to the not inconsiderable variations in the always minute proportion of organic matter present in the London supply, it is satisfactory to note that at periods of summer heat and drought like the present, the natural agencies at work to keep down the proportion of organic matter existing in the water of the river are at their maximum of activity. It results in this way, that the water supply of London is at its best just at those seasons, like the present, when any failure in the quality of the supply might be considered likely to be of exceptionally serious import.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

COLUMBIUM.†

The atomic weight of this metal has been determined by Rose, Hermann, Blomstrand, and Marignac. Rose‡ analysed a compound which he supposed to be chloride, but which, according to Rammelsberg,‖ must have been nearly pure oxychloride. If it was chloride, then the widely varying results give approximately Cb = 122; if it was oxychloride, the value becomes nearly 94. If it was chloride, it was doubtless contaminated with tantalum compounds.

Hermann's§ results seem to have no present value, and as for Blomstrand's,¶ I am not able to get at a copy of his original memoir. The results of the latter chemist are thus summed up in Becker's "Digest." Three chlorine estimations in the pentachloride give, in mean, Cb = 96·67. Eleven weighings of columbic acid from the same compound make Cb = 96·16. Other experiments on sodium columbate lead Blomstrand to regard 95 as the most probable value.

Marignac** made about twenty analyses of the potassium fluoxycolumbate, $CbOF_3.2KF.H_2O$. 100 parts of this salt give the following percentages:—

Cb_2O_5	Extremes	44·15 to 44·60	Mean 44·36
K_2SO_4	,,	57·60 ,, 58·05	
H_2O	,,	5·75 ,, 5·98	
F	,,	30·62 ,, 32·22	

From the mean percentage of Cb_2O_5, Cb = 93·217. If O = 16, this becomes 93·431.

From the mean between the extremes given for K_2SO_4, Cb = 93·812. If O = 16, this becomes 94·027.

As Deville and Troost's†† results for the vapour density of the chloride and oxychloride agree fairly well with Cb = 94, we may adopt this value as approximately correct.

TANTALUM.

The results obtained for the atomic weight of this metal by Berzelius,‡‡ Rose,‖‖ and Hermann,§§ may be fairly left out of account as valueless. These chemists could not have worked with pure preparations, and their data are sufficiently summed up in Becker's "Digest."

Marignac¶¶ made four analyses of a pure potassium fluotantalate, and four more experiments upon the ammonium salt. The potassium compound K_2TaF_7 was treated with sulphuric acid, and the mixture was then evaporated to dryness. The potassium sulphate was then dissolved out by water, while the residue was ignited and weighed as Ta_2O_5. 100 parts of the salt gave the following quantities of Ta_2O_5 and K_2SO_4:—

Ta_2O_5.	K_2SO_4.
56·50	44·37
56·75	44·35
56·55	44·22
56·56	44·24
Mean 56·59 ± 0·037	Mean 44·295 ± 0·026

* Smithsonian Miscellaneous Collections. The Constants of Nature."

† This name has priority over the more generally accepted "niobium," and therefore deserves preference.

‡ *Poggend. Annal.*, 104, 439. 1858.

‖ *Ibid.*, 136, 353. 1869.

§ *Journ. f. Prakt. Chem.*, 68, 73. 1856.

¶ *Acta Univ. Lund*, 1864.

** *Archives des Sci. Phys. et Nat.*, (2), 23, 258. 1865.

†† *Comptes Rendus*, 56, 891. 1863.

‡‡ *Poggend. Annal.*, 4, 14. *Lehrbuch*, 3, 1209.

‖‖ *Ibid.*, 99, 80. 1856.

§§ *Journ. f. Prakt. Chem.*, 70, 193. 1857.

¶¶ *Arch. des Sci. Phys. et Nat.*, 26, 89, serie 2. 1866.

From these figures, 100 parts of K_2SO_4 correspond to the subjoined quantities of Ta_2O_5:—

127·338
127·960
128·178
127·848

Mean 127·831 ± 0·120

The ammonium salt, $(NH_4)_2TaF_7$, ignited with sulphuric acid, gave these percentages of Ta_2O_5. The figures are corrected for a trace of K_2SO_4 which was always present:—

63·08
63·24
63·27
63·42

Mean 63·25 ± 0·047

Hence we have four values for Ta:—

From potassium salt, p.c. Ta_2O_5 ..	Ta = 183·033	± 0·343
,, ,, ,, K_2SO_4 ..	,, 181·619	0·242
,, ,, $K_2SO_4 : Ta_2O_5$ ..	,, 182·361	0·411
,, ammonium salt p.c. Ta_2O_5 ..	,, 182·149	0·456
General mean	,, 182·144	0·166

Or, if O = 16, Ta = 182·562.

If we assume K = 39, O = 16, F = 19, S = 32, and N = 14; the percentage of K_2SO_4 from K_2TaF_7 gives Ta = 181·912; and the analyses of the ammonium salt make Ta = 182·020.

Evidently, 182 is not far from the true value.

CHINESE IRON FOUNDRIES AND RICE PAN CASTING.

ALTHOUGH the Chinese, as a race, are incapable of the deep thought and extreme mental effort required to elaborate the intricate details of modern scientific machinery, or to plan those bold enterprises and extensive systems of road and hydraulic engineering which are the pride and glory of the British civil engineer, yet, *per contra*, it must be conceded that for finnicking, tedious, patient ingenuity of a certain sort, the Chinaman stands almost without a rival. As a notable example of this same patient plodding ingenuity, shown by the Chinaman in some of his trades and industries, may be instanced the manufacture of the very thin cast-iron rice pans which may be seen in almost any cook house in the Colony of Hongkong. The principal seats of this industry are at the towns of Sam-tiu-chuk, in the Kwei-shin district of the Wei-chow prefecture, and at the busy populous manufacturing town of Fatshan, situated in the Nam-hoi district of the Kwang-chow prefecture. This latter town is distant but some twelve miles, in a south-westerly direction, from the provincial capital of Canton, and has, from the extent and importance of its trade and manufactures, notably its great trade in iron goods, tools, and hardware, been aptly termed the Birmingham of China. The previously mentioned town of Sam-tiu-chuk is inhabited principally by Hakkas, and is one of the principal towns of the sparsely populated and mountainous district of Kwei-shin. The iron used is obtained by smelting the magnetic oxide, which is found in large masses in the mountains surrounding the town. The ore is broken up and smelted with charcoal in a primitive smelting furnace or cupola some eight feet high; the cupola is cone shaped, having its apex or smaller diameter at the bottom; the single tuyere pipe is of earthenware, the opening for emission of the blast being placed downwards. The furnace itself is of earthenware, or rather puddled and dried clay, kept from falling to pieces and strengthened by hoops and longitudinal straps of iron; the whole is lined with clay several inches thick; the internal diameter at the bottom may be about two feet or perhaps a little more, and at the top about three feet and a half, inside depth about six feet. The blast is produced by a rude yet most ingeniously contrived bellows, formed of a wooden box some five feet long by three feet in horizontal and a foot and a half in vertical section. This box is divided longitudinally into two compartments, each eighteen inches square in vertical section, in each of which compartments a piston works; the valves are so arranged that one piston is effective in the up, the other in the down or rather return stroke, for the machine is arranged horizontally. It will be seen, however, from this arrangement, as there is no air chamber, that the blast is not perfectly continuous, there being a slight cessation at the end of each stroke before the return stroke can be effective. The fuel used is charcoal, and the furnace being first heated by starting a fire with fuel alone is then filled up with alternate layers of charcoal and ore in small fragments. The blast is urged, and after a sufficient time has elapsed the molten metal is drawn off from a tap hole at the bottom in the usual manner and cast into ingots, which, when intended for export, are afterwards re-heated in an open forge and beaten into blooms of about six pounds in weight; these may occasionally be seen for sale in the iron dealers' shops in Hongkong, and when made from genuine native iron fetch a very high price indeed, as much as four dollars per picul or even more being sometimes paid for the best quality made from the black or magnetic oxide. The Fatshan iron, which to a great extent comes from Ying-tak (a town on the West River) is smelted from hematite (the red oxide) but mixed to a considerable extent with gangue, rarely pure, and of varying and uncertain chemical composition. The iron smelted from this latter ore, although far more valuable in the native estimation than foreign imported iron, yet does not realise so high a price in the market as the other.

For making the very thin rice pans which are cast without handles, pure native iron alone can be used; as being smelted with charcoal, it has the property, when melted, of being more fluid than iron smelted with coal; or it may be that the iron itself being uncontaminated with sulphur, or phosphorus, possesses the property of greater fluidity on this account. The moulds in which the pans are cast require weeks of tedious and patient labour to bring them to perfection. They are composed of two parts—an upper and a lower—and are made of carefully puddled clay, the upper portion about an inch and a half and the lower somewhat thicker; the lower or under half is full of round holes about half an inch in diameter, which pierce about two thirds the thickness of the mould; these holes are made in order to allow the clay to dry thoroughly; the the moulds are turned true on a revolving potter's table of the usual pattern, and when quite dry receive a final coating of fine moulding sand, and are made perfectly smooth. The two portions of the mould are then luted together with clay and placed in a large round oven some some six feet or more in diameter. The pans are cast bottom upwards, each mound having a runner but no riser; the upper portion of the mould has three little legs in order to support it when drying previously to the two moulds being luted together. After being placed in the oven, which is some two and a half feet deep, the moulds are surrounded with charcoal, which is fired, and the ovens closely covered with a curiously constructed earthenware, or rather dried clay cover, kept together, as in the case of the furnaces or cupolas previously mentioned, with bands and straps of iron. The process is so timed that by the time the moulds are at a bright red heat or almost white heat, the iron in the cupola is melted, and ready for tapping; the molten metal is then run out into ladles made for the purpose, and quickly poured into the moulds. When these are all filled, the cover of the oven is re-adjusted, and the whole left to anneal or cool gradually.

The great secret about this process, which enables the

Chinese founders to cast their iron pans of such large diameter, yet so thin and light as to be scarcely thicker than a sheet of paper, appears to be the use of highly heated moulds, and pure iron smelted with charcoal. When the ovens and their contents have cooled down, which takes about two days, the luting attaching the upper portion of the mould to the lower is carefully removed, and the moulds being separated the pan can be extracted; when the operation has been successful, the same mould can, with a little touching up, be used several times. The pans now have each attached to its bottom a runner or lump of iron, of greater or less size, which, from the extreme thinness of the pans, making them but little less brittle than earthenware, requires the greatest care in its removal; these runners are carefully sawn off, the use of the more expeditious cold chisel being more likely to cause fracture than the slower but steadier saw; the edges are smoothed down, and the pan is ready for the export market. Handles are attached to these pans by the retail dealers, who bore holes near the rim of the pan, and attach small ribbons of iron for the purpose of handles.

The pans made at Fatshan differ from the preceding in being cast with handles attached near the rim to the inner surface of the pan, which necessitates the breaking of the mould at each casting, it being rare for the same mould to be serviceable a second time. The Fatshan pans are also usually cast much thicker and heavier than those of Sam-tiu-chuk, and occasionally as large a proportion as one-third of foreign cast-iron, generally Kentledge or ordinary pig-iron, is mixed with the native iron for casting. In other respects the process followed at both places is the same. The Fatshan pans being thicker are the more durable of the two, while the thinner Kwei-shin pans are more popular with poor people because being thinner a less quantity of fire-wood is required to heat them through. The manufacture of iron rice pans is in Kwangtung province a Chinese Government monopoly, which is farmed out by the Salt Commissioner, and by him licenses are granted to the local iron founders on payment of a heavy fee. Considerable care has to be used in packing the pans for export, in order to prevent breakage, which, however, frequently occurs when any considerable number of pans are shipped to Australia or other distant ports. An attempt was made some years back to cast rice pans in Hongkong, but the locality chosen, Shau-ki-wan, being an unhealthy one, many of the workmen died, others left the place sickly and fever stricken, and the concern from this cause mainly proved a failure. It may, however, be possible that had a longer time, say a year or more, been allowed to elapse for the newly filled in ground to settle down, and the freshly cut hill side adjacent to finish giving off its malarious exhalations, the place would not have been so unhealthy, and in that case the result might not have been so disastrous to all concerned as it unfortunately proved itself to be.

T. I. B.

Hongkong, 19th March, 1884.

PROCEEDINGS OF SOCIETIES

SOCIETY OF CHEMICAL INDUSTRY.

Newcastle-on-Tyne, July 9th, 1884.

Address delivered at the Third Annual General Meeting by the Retiring President, WALTER WELDON, F.R.S., &c.:—

I trust that it will not be unfitting that the observations which it is now my duty to offer should be devoted exclusively to that one of the chemical industries of which the district in which we are now met is so important a centre, which was first practised in England within four miles of this building, and with which it happens that I am more familiar than with any other. Eighteen months ago, before the London Section of our Society, I sketched the then present condition of that industry, and indulged in some speculations as to its future. "Many things," however, "have happened since then"; and among them have been changes, alike in the actual condition of the older branch of the soda industry, and in the data for estimating the probable future of that industry at large.

Since I collected, towards the end of 1882, the statistics with respect to the soda industry which I presented to our London Section in January last year, the ammonia process has continued its victorious advance, and the production of Leblanc soda has still further diminished. That further diminution in the production of Leblanc soda was indeed inevitable; but, whereas one expected that it would involve the closing of more Leblanc soda works; temporarily, at any rate, this result has been avoided by combinations among Leblanc soda makers to reduce production. These combinations have been regarded as simply combinations to force up the price of certain products; but there is no room to doubt that the rise which has taken place in the price of the products in question, as a consequence of these combinations, must necessarily have taken place by this time if those combinations had not been formed. The manufacture of chlorine and Leblanc soda, without profit, and in many cases at a loss, could not have gone on much longer. It must soon have resulted in the forced withdrawal of the weaker manufacturers from a hopeless struggle; and the effect upon prices of diminished production brought about in this way would of course have been the same as that of diminished production brought about by mutual agreement. The stronger of the manufacturers might well have preferred a continuance of the struggle until all the weaker had gone to the wall; but the consumer has certainly no cause to complain of an arrangement (the faint flavour of socialism about which renders it none the less acceptable in at least my eyes) by which—instead of the complete closing of more works and the ruin of their owners, the other works remaining in full activity and reaping the whole benefit of the reduced production thus occasioned—on the one hand, the reduced production which must have been brought about in some way; and, on the other, the benefit of the higher prices resulting from it, are shared, as equally as may be, among the proprietors of all the works which were still in operation when that arrangement was made.

While, however, the makers of soda by the Leblanc process are to-day in the position, to which they had so long been unaccustomed, of being able, not only to make both ends meet, but also, I trust, to make one end somewhat overlap the other—what of the future of that process? Regarded merely as a means of manufacturing soda it has served its time. Per given quantity of soda yielded by it, it is more than 70 per cent more costly than the ammonia process; and thus its only claim to continue to live consists in the fact that it yields hydrochloric acid. So far as one can yet see the world must continue to be supplied with chlorine. At present, the immediate raw material of the chlorine manufacture is always hydrochloric acid; and for our supply of that raw material we are entirely dependent on the Leblanc process. Is this state of things destined to continue? Is the Leblanc process likely to remain our only means of obtaining hydrochloric acid? And, above all, must the production of hydrochloric acid always be, as now, an essential condition precedent of the production of chlorine?

How to obtain, in a useful state, the chlorine, at present thrown away as calcium chloride, of the salt which is decomposed by the ammonia process, is a problem which has long occupied many minds. When it became known, in the course of last year, that Mr. Mond had patented a process to that end, it was widely felt that the solution of this problem had probably been reached; and Mr. Mond's very ingenious process certainly would, under given conditions, enable the manufacturer of ammonia soda to utilise both the constituents of the salt which he decomposes. Mr. Mond himself, however, has never regarded

this process as other than a process for the future. It is a process which would involve that the ammonia employed in the manufacture of ammonia soda, instead of being continually regenerated and used again as at present, should be used as a reagent in that manufacture only once, and should then be sold as ammonium sulphate; and hence the conditions for its extensive application obviously do not at present exist.

The form of Mr. Mond's process is due to a fact of which, until he discovered it, chemists were not aware. We know that when sodium chloride is heated with an equivalent of sulphuric acid, as in the first operation of the Leblanc process, the sulphuric acid reacts on only one-half of the sodium chloride, the products of its reaction thereupon being HCl and hydrogen sodium sulphate; but that afterwards, at a higher temperature, that hydrogen sodium sulphate reacts on the other half of the sodium chloride, another HCl being evolved, and the whole of the sodium present being converted into normal sulphate. It has been generally supposed that if ammonium chloride were substituted for sodium chloride things would go in a similar way; but Mr. Mond has found that this is not the case. He has found that when ammonium chloride and acid ammonium sulphate are heated together no reaction takes place between them at whatever temperature. Below a certain temperature nothing happens; above that temperature, all that happens is that ammonium chloride volatilises. That this fact remained to be discovered in 1883 surely shows that, in the search for new organic compounds in which chemists for so many years past have been so absorbed, the pursuit of inorganic chemistry has been somewhat unduly neglected.

When the residual liquor of the ammonia soda process has been treated for the distillation off from it of such part of its ammonia as is combined with carbonic acid, together with such of it, if any, as may be in the free state; what remains is a nearly saturated mixed solution of ammonium and sodium chlorides. On evaporating this mixed solution, its sodium chloride, being the less soluble of the two salts contained in it, falls, and may be fished out, leaving eventually a mother-liquor consisting of solution of ammonium chloride only. Mr. Mond's proposed process consists in separating in this way the sodium chloride of the mixed solution in question; in then evaporating the mother-liquor to dryness, so as to obtain solid ammonium chloride; and in then treating this solid ammonium chloride by enough sulphuric acid to form ammonium acid sulphate, HNH_4SO_4, the chlorine of the ammonium chloride going off as HCl. The residual acid ammonium sulphate is then either to be treated by vapour of free ammonia, and so converted into normal ammonium sulphate for sale as such, or it is to be used, instead of free sulphuric acid and normal ammonium sulphate, in the manufacture of richly ammoniacal phosphatic manures.

If one wished to convey an idea of the stupendous scale upon which ammonia soda is now manufactured, I think one could not do it better than by pointing out some of the conditions which would be necessary to the application of this process to the whole of the ammonium chloride produced by a single ammonia soda maker, Mr. Mond himself. It is no secret that Mr. Mond manufactures fully 50,000 tons of ammonia soda per annum. To treat the whole of the ammonium chloride corresponding to this quantity of ammonia soda by that form of the process in question in which the acid ammonium sulphate at first produced should be afterwards converted into normal ammonium sulphate by means of free ammonia, would require, not only that he should manufacture per annum 128,000 tons of ammonium sulphate, but also that he should command a constant supply of one-third more ammonia than the total quantity at present produced in all Great Britain and Ireland; while to treat that vast quantity of ammonium chloride by the form of his process in which the acid ammonium sulphate intermediately produced should be employed to react on calcium phosphate, he must manufacture per annum a quantity of manures containing 64,000 tons of ammonium sulphate, which quantity of manures could not, I believe, be less than 350,000 tons, or 40 tons for every hour in the whole year, and the production of which would require a supply of ammonia equal to two-thirds of the total quantity at present produced in all the gas works of the United Kingdom. It would involve the annual consumption of a quantity of ammonia,—the production of which in gas works at present requires the distillation of five millions of tons of coal, and the concentration of which, as gas-liquor, upon any one spot, would require that gas-liquor should come pouring in there at the rate of from a ton to a ton-and-a-half per minute, night and day, weekdays and Sundays, all the year through.

Obviously—and, as I have said, I know that this is Mr. Mond's own view—this process cannot be extensively applied so long as we continue dependent for our supply of ammonia mainly on the distillation of coal for the manufacture of illuminating gas; and cannot, indeed, be applied on any serious scale at all except in proportion as means are realised of obtaining as ammonia the nitrogen of coal used as fuel, and as those means are practised in the immediate neighbourhood of ammonia soda works. Such means doubtless will be realised; but very much will happen before the supply of ammonia becomes so abundant as to permit the ammonia soda maker to use his principal reagent only once and then to sell it; and when that time at length arrives I think he will have no temptation to treat his ammonium chloride by sulphuric acid, but if he desires to sell his ammonia, after having used it only once, will probably best find his account in selling it in the form in which his soda process yields it. Meanwhile, I believe that Mr. Mond is not only not preparing to put this process into operation, on any scale whatever, but has no immediate intention of doing so.

An idea for the obtainment of hydrochloric acid in connection with the ammonia process, which has found more favour in many eyes than I think it deserves, and has recently been the subject of very much experiment, is one involving a modification of the ammonia process itself, by the substitution of sodium sulphate for sodium chloride as its starting-point. The idea is to first decompose salt by sulphuric acid, and so obtain hydrochloric acid and sodium sulphate, as in the Leblanc process at present, and then to treat that sodium sulphate by ammonia and carbonic acid. The experiments which have been made in this direction at least place beyond doubt—what before was widely disbelieved—namely, that a sulphate of soda ammonia process, whatever its commercial merits or otherwise, is in itself perfectly practicable. The lower solubility, in water at ordinary temperatures, of sodium sulphate than of sodium chloride, has been supposed to be an obstacle to the realisation of such a process; but there is no inconvenience in employing, in the operation of decomposing sodium sulphate by bicarbonate of ammonia, a temperature of about 34° C., and at that temperature sodium sulphate is more soluble than sodium chloride: so that it is quite practicable to obtain, by treating by CO_2 an ammoniacal solution of sodium sulphate, more bicarbonate of soda than can be obtained by the corresponding treatment of an equal volume of ammoniacal brine. It has also been supposed that only one-half of the sodium sulphate treated by ammonia and carbonic acid would undergo decomposition, the second half of it going to form, with the ammonium sulphate resulting from the reaction of bicarbonate of ammonia on the first half of it, double sulphate of sodium and ammonium; but experience has proved that this is not so. Nor does the regeneration of ammonia by means of lime from the ammonium sulphate of the mother-liquor of a sulphate of soda ammonia process present any difficulty. The operation can not be performed, owing to the formation in it of solid and bulky calcium sulphate, in precisely the same manner as the corresponding operation of the present form of the ammonia process; but means have been found of effecting it with an ease and completeness which leave nothing to be desired. It has been found, too,

that that calcium sulphate can be readily separated from so much of the residual solution, containing a good deal of sulphate of soda, in which it is at first suspended, that, —the separated solution being used to dissolve the next quantity of solid sodium sulphate entering the process—the loss of sodium sulphate in a sulphate of soda ammonia process need be only extremely small. It seems quite clear, therefore, that such a process would present no practical difficulty whatever.

But, *cui bono?* To merely substitute for the Leblanc method of decomposing sodium sulphate its decomposition by bicarbonate of ammonia, would surely be a game not worth the candle. In the Leblanc process, as in so many other things, *c'est le premier pas qui coûte*. It is the first operation of the Leblanc process which makes that process so costly. It is the cost of his sodium sulphate which places the maker of Leblanc soda at such a disadvantage as compared with the maker of ammonia soda. If sodium sulphate cost the former no more than salt costs the latter, it is Leblanc soda, and not ammonia soda, which would be the cheaper of the two; since the cost of manufacturing Leblanc soda from sodium sulphate is appreciably less than the cost of manufacturing ammonia soda from salt. The treatment of sodium sulphate by ammonia and carbonic acid would at least not be less costly than the treatment of sodium chloride by the present form of the ammonia process; and hence to merely substitute for the Leblanc method of decomposing sodium sulphate the method of decomposing it by bicarbonate of ammonia would be to substitute for the later operations of the Leblanc process a series of more costly operations, having no advantage beyond one of scarcely appreciable commercial value, that of yielding a more concentrated product.

While, however, the only advantage of a process which should consist in manufacturing sodium sulphate as in the Leblanc process at present, and then decomposing that sodium sulphate by bicarbonate of ammonia, would thus be one which would not be worth the cost of obtaining it; a process, based on the decomposition of sodium sulphate by bicarbonate of ammonia, has recently been devised, which stands upon a very different footing. In the process to which I now refer the sodium sulphate to be afterwards decomposed by bicarbonate of ammonia would be obtained, and hydrochloric acid at the same time, without consumption of sulphuric acid, except to make up mechanical loss, by means of one and the same quantity of sulphuric acid continually regenerated and used again.

This remarkable process is the invention of three members of the firm of Gaskell, Deacon, and Co., of Widnes: Mr. Carey, Mr. Holbrook Gaskell, junr., and Dr. Hurter. These gentlemen have found a means of so decomposing ammonium sulphate as to obtain, not only its ammonia in the free state, but also its sulphuric acid, if not as free sulphuric acid, at any rate in a state in which it can decompose sodium chloride.

Chemists have long known that when ammonium sulphate is heated to a certain temperature one-half of its ammonia is set free and flies off, the other half of it remaining behind as hydrogen ammonium sulphate. Messrs. Carey, Gaskell, and Hurter have discovered that if a mixture of equivalent quantities of ammonium sulphate and sodium sulphate be heated to fusion, and steam be injected into the liquid mass, the whole of the ammonia of the ammonium sulphate is disengaged in the free state: its sulphuric acid combining with the sodium sulphate to form hydrogen sodium sulphate, which alone remains behind.

Upon this most interesting reaction there may obviously be based a soda process which should begin by obtaining sodium sulphate and hydrochloric acid by the reaction of "bisulphate of soda" on sodium chloride, the normal sodium sulphate so obtained being then decomposed by bicarbonate of ammonia, with production of bicarbonate of soda and ammonium sulphate, such ammonium sulphate being then so treated as to regenerate, by one and the same operation, both ammonia for use again and bisulphate of soda for use again.

The question of whether or not this most original and beautiful process can be reduced to practice must obviously depend, mainly if not solely, upon the degree of readiness with which the new reaction upon which it is based can be carried to such completeness as to avoid any serious loss of ammonia. I am unacquainted with the experimental results on this point which have so far been obtained; but it is easy to see that that reaction might be somewhat slow, and, therefore, somewhat costly, and yet the process based upon it be one of very serious importance.

Charging against the hydrochloric acid yielded by Messrs. Carey, Gaskell, and Hurter's process the cost of those operations of their process which are in excess of the operations which the ammonia soda maker performs at present, one may count that the cost of their soda would be practically the same as that of ammonia soda as at present manufactured from brine. Their process would start from solid salt, which is, of course, more costly than brine; but, in some localities, at any rate, the value of the lime which is required for the decomposition of the ammonium chloride of the present form of the ammonia process, but which would not be required in Messrs. Carey, Gaskell, and Hurter's process, would fully compensate the greater cost for raw materials of the latter than of the former.

The operations, the cost of which would thus have to be charged against Messrs. Carey, Gaskell, and Hurter's hydrochloric acid, are those: firstly, of evaporating to dryness the mixed solution of ammonium sulphate and sodium sulphate constituting the mother-liquor of the bicarbonate of soda obtained by treating an ammoniacal solution of sodium sulphate by carbonic acid; secondly, of treating the residue of that evaporation, after addition to it of more sodium sulphate, for the regeneration of ammonia and the production of bisulphate of soda; and, thirdly, of then furnacing that bisulphate of soda with an equivalent quantity of salt.

The quantity of water which would have to be evaporated, in the first of these three operations, per ton of sodium carbonate manufactured, may be put, I believe, at five-and-a-half tons. It would be the water of a mixed solution of ammonium sulphate and sodium sulphate, and as these are both salts which, like sodium chloride, absorb heat during solution in water, and so give out heat during the inverse operation,—the two together in the proportions in which they would be present in the solution in question, to just about the same extent as sodium chloride,—it ought to be possible to evaporate those five-and-a-half tons of water by means of the one ton of fuel which suffices for the evaporation of more than that quantity of water from brine. For the third operation, which would correspond to the second half of the first operation of the Leblanc process, less than half-a-ton of fuel should be ample. The labour upon these two operations would obviously be but slight, so that the cost of both operations together, for fuel and labour, per ton of sodium carbonate manufactured, could scarcely, I think, exceed eleven or twelve shillings.

The quantity of hydrochloric acid which corresponds to the quantity of sodium chloride corresponding to a ton of sodium carbonate, counted as aqueous acid of 27 per cent, is 2·548 tons. There are some Leblanc soda works in which the proportion of the total HCl evolved therein, which is obtained as aqueous acid of useful strength, is fully 95 per cent. Assuming this proportion of the HCl evolved in Messrs. Carey, Gaskell, and Hurter's process to be obtained in an useful form, the process would yield, per ton of sodium carbonate manufactured by it, a quantity of aqueous acid corresponding to 2·42 tons at 27 per cent.

The value of this quantity of hydrochloric acid I estimate at £2 8s., and I arrive at that value for it in this way. The difference between the cost of ammonia soda and that of Leblanc soda, *plus* hydrochloric acid, per quantity of Leblanc soda equivalent to a ton of ammonia soda, now averages, I believe, in England, about £2 15s.

These £2 15s. I take to be the value, in the sense of the actual cost, not of the quantity of hydrochloric acid, of useful strength, which is usually obtained concurrently with that quantity of Leblanc soda, but, what is by no means the same thing, of the greatest quantity of such acid which is obtained, per such quantity of soda, in any instance within my knowledge. This quantity,—for we must remember that the Leblanc soda maker has to produce more sodium sulphate, and, consequently, more hydrochloric acid, than merely the quantity equivalent to the alkali he finally obtains,—is 95 per cent of the quantity corresponding to about twelve-and-a-half per cent more sodium sulphate than the quantity of sodium sulphate equivalent to a ton of sodium carbonate, and is thus, counted as acid of 27 per cent, almost exactly two and-three-quarter tons: £2 15s. for which quantity is just £1 per ton, or £2 8s. for the 2·4 tons which I have taken to be obtainable, by the process under consideration, per ton of sodium carbonate manufactured thereby.

Taking it, then, that the minimum present cost of aqueous hydrochloric acid of 27 per cent is £1 per ton; that Messrs. Carey, Gaskell, and Hurter's process could yield, per ton of sodium carbonate manufactured by it, 2·4 tons of such acid, thus worth at least £2 8s.; and that, of the three operations the cost of which would have to be charged against those 2·4 tons of hydrochloric acid, twelve shillings would pay for two: there would thus remain £1 16s., the balance left after the deduction from which sum of the cost of effecting Messrs. Carey, Gaskell, and Hurter's reaction on about 2 tons 12 cwt. of a mixture of ammonium sulphate and sodium sulphate, would be the measure of the advantage of their process over the Leblanc process.

It is so difficult to conceive that the cost of effecting the reaction in question upon the quantity of materials which I have mentioned could be anything like £1 16s., that for this process of Messrs. Carey, Gaskell, and Hurter's I could not but anticipate a most important future; were it not for the results of a renewed attempt which has for some time past been in progress to realise the old idea of decomposing the ammonium chloride of the present form of the ammonia process by magnesia, and then so treating the resulting magnesium chloride as to obtain its chlorine in a useful form and at the same time to regenerate magnesia for use again, In this method of procedure there would be one operation less than in Messrs. Carey, Gaskell, and Hurter's process: the operation of evaporation, which would be practically the same in both processes, being followed in Messrs. Carey, Gaskell, and Hurter's process by two operations, in the first of which there would be treated, per ton of sodium carbonate manufactured, about 52 cwts. of mixture of sodium sulphate and ammonium sulphate, and in the second about 68 cwts. of mixture of sodium chloride and hydrogen sodium sulphate, while, in what may be called the magnesia process, the operation of evaporation would have to be followed by simply the one operation of decomposing about eighteen-and-a-half hundredweight of magnesium chloride. To which must be added the far graver consideration, that while Messrs. Carey, Gaskell, and Hurter's process can yield the chlorine of salt treated by it only as hydrochloric acid, a large part of the chlorine of magnesium chloride can be obtained directly in the free state.

It is MM. Pechiney et Cie., of Salindres, in the South of France, who have had the boldness to attack again the problem,—upon which so many earnest workers had spent in vain their utmost efforts during many years,—of how to obtain, as magnesium chloride, the chlorine of the salt decomposed by the ammonia process; and their genius and skill have enabled them to reach results which compel the conviction that the industrial realisation of the decomposition by magnesia of the ammonium chloride of the ammonia process is now only a question of time.

If, then, the manufacturer of ammonia soda shall become able, as he certainly will become able, to obtain as magnesium chloride the chlorine which he at present throws away as calcium chloride, how is that magnesium chloride to be dealt with? When an aqueous solution of magnesium chloride is subjected to evaporation, vapour of hydrochloric acid begins to be disengaged so soon as the quantity of water present has fallen to six equivalents, per equivalent of magnesium chloride. Fifteen or sixteen years ago, at the Gerard's Bridge Works of Messrs. J. C. Gamble and Son, of St. Helens, very considerable quantities of solution of magnesium chloride, concentrated to that point, were treated in muffle furnaces. The magnesium chloride was readily enough decomposed, but the furnaces were rapidly destroyed—by reason of the concentrated solution fed into them penetrating their beds—and causing the beds to "rise." The Gerard's Bridge experiments on the decomposition of magnesium chloride were therefore abandoned; but not until they had proved that the difficulties in the way of decomposing that compound industrially by heating it in an atmosphere of vapour of water, were simply mechanical difficulties.

Seeking, during many years subsequently, means of treating by heat and air, under industrial conditions, chlorides of various metals, I was at length led, in 1881, to the idea of adding to a concentrated solution of a chloride or mixture of chlorides, oxide of the same metal or metals, and then treating by heat and air solid masses of the resulting mixture; and since early in 1882, MM. Pechiney et Cie. have been earnestly engaged in endeavouring to realise this method of working: especially as applied to magnesium chloride, enormous quantities of which they obtain as a by-product of the manufacture of salt from sea-water, and also to manganese chloride. In the case of magnesium chloride, the product of the addition to its aqueous solution of magnesium oxide is, of course, not a mere mixture, but the compound, magnesium oxy-chloride. I had found in the laboratory that this body, heated in contact with air under certain conditions, gives off an appreciable part of its chlorine in the free state; and the larger experiments which have since been made at Salindres leave no doubt that fully half the chlorine of magnesium chloride may be obtained directly as free chlorine by converting the magnesium chloride into oxy-chloride, and then heating that oxy-chloride, under certain conditions, in presence of air. What this means is that a manufacturer of ammonia soda, able to decompose his ammonium chloride by magnesia, will be able, by evaporating, per ton of ammonia soda manufactured, a quantity of solution of magnesium chloride containing about five-and-a-half tons of water, and then heating in presence of air a mixture of about eighteen-and a-half hundredweight of magnesium chloride with about eight hundredweight of magnesia, to obtain the quantity of free chlorine corresponding to very nearly a ton of bleaching-powder,—being the quantity of chlorine the present cost of which, as I shall show in a moment, is close upon £6,—and, in addition, a quantity of hydrochloric acid corresponding to something over a ton of aqueous acid of 27 per cent. The chlorine obtained by heating magnesium chloride in contact with air is of course diluted by other gases; but MM. Pechiney et Cie. have in operation an extremely simple mechanical bleaching-powder chamber, the complete absorption in which of the chlorine of a mixture of chlorine and other gases presents no difficulty.

(To be continued.)

The Probability of a Transformation of Strychnine in the Animal Organism.—P. C. Plugge.—The author is engaged with the examination of strychnic acid—an oxidation product of the base. Strychnic acid is a monobasic acid, not bitter, and in doses of 16 to 20 milligrms. has no poisonous action upon frogs, pigeons, and rabbits. With sulphuric acid and potassium bichromate it gives a splendid red-violet colour, which then becomes red and fades away. (Strychnine gives *first* a blue-violet colour, which afterwards turns to a red-violet.)—*Zeitschrift fur Analytische Chemie.*

CORRESPONDENCE.

THE ACTION OF ARSENIOUS ANHYDRIDE UPON GLYCERIN.

To the Editor of the Chemical News.

SIR,—The compound recently described by Mr. Herbert Jackson (CHEM. NEWS, vol. xlix., p. 258)—

$$\left.\begin{matrix} C_3H_5 \\ As \end{matrix}\right\} O_3$$

was discovered by H. Schiff in 1867 (*Bull. Soc. Chim. de Paris*, (N.S.), vol. viii., p. 99).

Like Mr. Jackson I re-discovered this compound shortly before I heard of Schiff's paper.—I am, &c.,

EDWARD E. BERRY.

8, Belle Vue, Cotham, Bristol,
July 21, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 24, June 16, 1884.

Description of a New Evaporation and Distillation Apparatus for the Pneumatic Treatment of Saccharine Liquids.—P. Calliburgès.—This apparatus cannot be intelligibly described without the accompanying figures.

On Certain Colloidal Compounds, derived from Ferric Hydrate.—E. Grimaux.—The solutions in question are compounds of glycerin, ferric hydrate, and alkalies or alkaline carbonates. Their composition has not been determined, as the jellies which they yield on coagulating are decomposed on prolonged washing, and leave merely ferric hydrate. Their reactions show that they are easily dissociated by water into glycerin and insoluble compounds richer in ferric hydrate. Mannite and erythrite behave similarly to glycerin.

Detection of Nitric Acid and Nitrates in Vegetable Tissues.—A. Arnaud and L. Padé.—Cinchonamine nitrate is almost absolutely insoluble in water acidulated with any acid whatever. If into the solution of a nitrate we pour a small quantity of a salt of cinchonamine previously dissolved in water acidified with hydrochloric acid nitrate of cinchonamine is thrown down. It appears probable that the nitrates may be determined in this manner, as the nitrate of cinchonamine is completely insoluble in an acid solution, and its composition is definite and constant ($C_{19}H_{24}N_2O,NO_3H$). The detection of nitric acid may be advantageously effected by this method.

Soldering Aluminium.—M. Bourbouze.—The author asserts that hitherto it has been found impracticable to solder aluminium either to itself or to other metals. He proposes to coat those parts which are to be joined together either with an alloy of tin and zinc, or of tin and aluminium.

Purification of Arseniferous Zinc—L. L'Hote.—The author throws into the melted zinc 1 to 1½ per cent of anhydrous magnesium chloride. On stirring there are given off white fumes of zinc chloride which carry off the arsenic. If the metal is granulated in cold water, it is found completely free from arsenic. The same process removes antimony, which is rarely present in the zinc of commerce.

No. 25, June 23, 1884.

Universal Presence of Nitrates in the Vegetable Kingdom.—M. Berthelot.—The author has, for a year, been especially engaged with an examination of the nitrates present in the tissues of certain plants, with their origin, and the part which they play in vegetable physiology. His experiments tend to establish the existence of a new vegetable function, giving rise to the formation of nitrates in certain vegetable tissues, and during a determined period of vegetation. It results from the action of certain cellules acting doubtless after the manner of the nitric ferment of MM. Müntz and Schlœsing.

On Certain Phenomena of Occlusion.—P. Schutzenberger.—The author refers to the fact that oxygen prepared from a mixture of potassium chlorate and manganese dioxide carries along with it a considerable quantity of chlorine and oxides of chlorine. Such oxygen, tho ugh well washed with water and kept for two or three weeks in a metal gas-holder in presence of a considerable volume of water, still retains, so to speak, a reflection of the odour of chlorine, and attacks caoutchouc tubes like ozone. Still such oxygen may be allowed to bubble slowly for hours through a solution of silver nitrate, or through water faintly coloured with blue litmus, or with sodium indigotate, without producing the reactions of chlorine, or hydrochloric acid, or of one of the oxygen acids of chlorine. If, on the contrary, the current of oxygen, before being submitted to these reagents, is passed through a narrow platinum tube at one point, the presence of chlorine is distinctly shown; the indigo is bleached and the silver nitrate is precipitated. The author thinks that this is a case where the one gas is occluded in the other. He gives, also, a case when watery vapour is occluded by potassium chromate, which may occasion errors when the latter compound is used in organic analysis. Oxygen is also sometimes retained in an abnormal state by copper oxide.

Novel Method for the Synthesis of Nitrogenous Organic Compounds. Total Synthesis of Xanthine and Methyl-xanthine.—Arm. Gautier.—The regulated polymerisation of hydrocyanic acid in presence of water yields xanthine and methyl-xanthine. If, in the above reaction, the water is replaced by the various mono- or poly-atomic alcohols, the acetones, aldehyds, phenols, &c., we obtain an almost indefinite series of new compounds.

On Potassium and Barium Glyoxal-bisulphites.—M. de Forcrand.—A thermo-chemical paper, which does not admit of useful abridgment.

On Colloidal Ferric Salts.—E. Grimaux.—The salts described are potassinm ferri-tartrate, the ferric arseniate and arsenite.

Researches on the Xylenes.—A. Colson.—The author has resumed the comparative study of the alcohols derived from these carbides. He describes in the present paper the diatomic alcohols, orthoxylenic glycol (the phthalic alcohol of Hessert), with the orthoxylenic bi-bromide and bi-chloride.

The Natural Saltpetres of Chili and Peru, as concerns Rubidium, Cæsium, Lithium, and Boric Acid. Inferences relative to the Beet-root Lands of North France.—M. Dieulafait.—M. Grandeau in 1863 pointed out the richness in rubidium of the salts from the beet-root of North France. He shows at the same time the absence of cæsium and lithium. The author has examined 14 salts prepared from the beet-roots of Lower Normandy, from land never manured with foreign saline matter, and finds in them neither rubidium nor cæsium, whilst the spectrum of lithia was often intense. Latterly he has examined a sample of the mother-liquor from refining nitre in Chili. In opposition to the results of Kirchoff, Bunsen, and Grandeau, the author found these waters rich in rubidium, very poor in lithium, and probably free from cæsium. Soils which are dressed yearly with crude nitre receive a considerable proportion of rubidium. The law of association of rubidium and cæsium with lithium, proposed by Kirchoff and Bunsen, which seemed to be contradicted by the absence of lithium in beet-root, is now confirmed.

Zeitschrift für Analytische Chemie.
Vol. xxiii., Part 2.

Determination of Nitrogen in Organic Substances.—A number of processes are given, the more important of which have been already noticed.

The Determination of Starch in Articles of Food.—C. Faulenbach.—The author begins the conversion into sugar by means of diastase. When all the starch is dissolved he filters off the cellulose and completes the conversion into sugar by means of hydrochloric acid.

Precipitation of Glucose by Basic Lead Acetate.—P. Lagrange.—From the *Comptes Rendus.*

Determination of Cane Sugar by Polarisation after Inversion.—P. Casamajor.—From the Chemical News.

Determination of Carbonic Acid in Air.—A. Muntz and E. Aubin.—From the *Comptes Rendus.*

Analysis of Milk.—A notice of processes which have appeared in the Chemical News and the *Analyst.*

The Rapid Determination of Salicylic Acid in Beverages.—A. Remont.—From the *Comptes Rendus.*

The Adulteration of Cheese.—A. Langfurth.—The author examines the quantity of decinormal soda-lye respectively required for saturating equal weights of the fatty acids of natural and of factitious cheeses.

Examination of Wall Papers.—A. Gawalovski.—The author fills a large wide-mouthed bottle with clippings of the paper, and sets upright in it three large test-tubes, one half-filled with luke-warm water, another half-filled with carbonic acid water, and a third half-filled with ordinary vinegar. The glass is now closed, and two slips of filter-paper wedged in between the neck and the stopper,—the one steeped in lead acetate and the other with silver nitrate. The whole is let stand for some days. If the lead-paper is blackened, the author considers the paper injurious as emitting sulphuretted hydrogen. If the silver paper remains black after it has been steeped for two hours in a 10 per cent solution of potassium cyanide, the paper is condemned as giving off hydrogen arsenide.

The Detection of Petroleum added to Oil of Turpentine.—H. C. Armstrong.—From the *Journal of the Chemical Society.*

The Detection of Carnauba Wax.—E. Valenta.—Table showing the melting-points of carnauba wax, commercial stearic acid, ozokerite, paraffin, and of various mixtures.

Examination of Tallow.—O. Wolckenhaar.—A statement of the specific gravities and melting-points of ox- and mutton-tallow.

Analysis of Oils.—Papers by Bach, David, and Krechel, which do not admit of useful abstraction.

Scheme for the Analysis of Soaps.—A. R. Leeds.—Already noticed.

Examination of Acetate of Lime.—F. Gœbel.—The author employs a soda-lye of which 1000 c.c. exactly neutralise 100 grms. acetic acid and a phosphoric acid equivalent to the soda-lye. A weighed portion of the sample is mixed in an evaporating basin with a measured excess of the phosphoric acid and evaporated to dryness on the water-bath. The residue is re-dissolved in water and again evaporated, repeating the operation until no odour of acetic acid is perceptible. It is then dissolved in water and the excess of acid is titrated with soda-lye, using phenol-phthaleine as indicator. The phosphoric acid required for saturating the bases is calculated as acetic acid. The result thus obtained is too high, since the caustic lime and carbonate of lime, always present in the commercial salt, figure here as acetate. We determine, therefore, in a fresh portion of the original sample the quantity of hydrate and carbonate of lime by titration with hydrochloric acid, equivalent to the soda-lye employed, using litmus as indicator. The result is calculated as acetic acid and subtracted from the former amount.

Valuation of Yeast.—E. Meissl.—The author's method turns on the determination of the carbonic acid evolved from a standard saccharine solution.

Detection of the Eosines.—R. Benedikt.—Already noticed.

Separation of Aniline, Paratoluidine, and Orthotoluidine.—L. Lewy.—The hydrochlorates of these bases are mixed with sodium phosphate. There are formed, sparingly, soluble aniline and paratoluidine phosphate along with soluble acid, orthotoluidine phosphate, and free orthotoluidine. After this decomposition, the two first mentioned salts are kept in solution by the application of heat, the only supernatant layer of orthotoluidine is syphoned off, and the salts of aniline and paratoluidine are allowed to crystallise out. The mother-liquor contains the acid orthotoluidine phosphate. On separating the bases by means of soda the sodium phosphate is recovered.

Determination whether a Photographic Emulsion has been Boiled too long.—Otto Pfenniger.—Solution of tannin is added; the emulsion turns a reddish-brown if it has been boiled too long.

Rapid Valuation of Hydraulic Cements.—E. Landrin.—From the *Comptes Rendus.*

Determination of Carbon Disulphide in the Sulphocarbonates.—A. Muntz and E. Falieres.—From the *Comptes Rendus.*

Detection of Resin in Ethereal Oils.—A. Belohoubek.—The author mixes a drop of the ethereal oil in a dry test-tube, at first with one drop of petroleum ether, then with two, and gradually with several. If resin is present a white precipitate, or at least an opalescence, appears.

A Test for the Ethereal Oil of Juniper.—G. Thoms.—The author mixes a drop of the oil with 5 c.c. alcohol, and a drop of officinal tincture of iodine. If the oil is pure the yellow colour of the liquid disappears in a few seconds on shaking.

Hager's Microscopic Method for the Detection of Arseniate in Sodium Phosphate and Nitrate.—The author has once detected arsenic acid in sodium nitrate and leaves it an open question whether this impurity occurs more frequenty. He rubs several crystals to powder, and heats 0·05 grm. along with 0·15 grm. in a small, short dry test-tube, until an escape of gas can no longer be detected. Upon the residue he pours about 1 c.c. dilute arsenic acid, adds then a few granules of oxalic acid and 0·5 c.c. of water, lets dissolve, and puts 1 to 2 drops upon a thin glass slip. He evaporates to dryness over a petroleum lamp and heats for a few moments until white fumes arise. Under the microscope there appear colourless crystalline deposits, and, if arseniate is present, black, opaque ramifications and margins.

The Solubility of Calcium Phosphate in Urine.—B. J. Stokvis.—The phosphatic precipitate formed on boiling urine free from albumen consists of basic calcium phosphate, containing occasionally traces of calcium phosphate and carbontate, but entirely free from magnesium compounds. On cooling, it re-dissolves, whilst the original neutral phosphate is re-formed.

Determination of Chloroform in the Blood.—MM. Gréhaut and Quinquaud.—From the *Comptes Rendus.*

A Simple Apparatus for Determining Urea with Sodium Hypobromite.—W. H. Greene.—From the *Comptes Rendus.*

Sulpho-diazo-benzol as a Reagent for Bilirubine.—P. Ehrlich.—The author has tested the bile pigments, bilirubine, bilifuscine, biliprasine, bilihumine, and urobiline, with recently prepared solutions of diazol-benzol. The so-called Ehrlich's reagent, containing 1 grm. sulphanilic acid, 15 c.c. hydrochloric acid, and 0·1 grm. sodium nitrite in 1 litre of water. Bilirubine alone gave charac-

teristic colour phenomena. Its solution in chloroform, mixed with 1 or 2 vols. of the reagent and then with alcohol enough to form a homogeneous liquid, gives a play of colours for about a minute. The yellow colour turns to a red, and on the gradual addition of strong hydrochloric acid passes through violet to an intense splendid blue. This blue pigment is permanent, but displays its beautiful blue colour only in strongly acid liquids; in presence of strong alkalies it is a greenish-blue, and in neutral, feebly alkaline, or feebly acid liquids it appears red. In testing urine for bilirubine, Ehrlich adds first an equal volume of dilute acetic acid, and then the solution of sulpho-diazobenzol. If the mixture darkens, a further addition of an acid, *e.g.*, glacial acetic acid, brings up the characteristic colour of bilirubine.

Pigments formed on Heating Urine with Acids.—P. Plósz.—The change of colour is due to the production of a number of pigments, one of which named uromelanine, by Plósz, constantly appears, whilst urorubine and indigo occur very frequently. Uromelanine is probably identical with Heller's "urrhodine" and Thudicum's "uromelanine."

The Determination of Globuline in the Serum of the Blood.—A. E. Burckhardt.—The "globuline" obtained by Hammarsten's process is a mixture of two albumenoids, paraglobuline, and a body having many properties in common with the albumens.

The Optical Determination of Hæmoglobine.—The error in Vierordt's instrument is overcome if the slit is provided with Kruss's arrangement.

Preparation of Sulphuretted Hydrogen free from Arsenic.—R. Otto.—The author prepares sulphuretted hydrogen for judicial analyses from calcium or barium sulphide with pure non-arsenical hydrochloric acid.

Researches on the smallest Fatal Dose of the Alkaline Chlorides.—C. Richet.—From the *Comptes Rendus*.

On Cantharidine.—E. Dietrich.—Cantharidine dissolves in 30,000 parts of cold and 15,000 parts of hot water. Its solubility is increased by the presence of a small quantity of sulphuric acid or of an ethereal oil.

The Ptomaines.—A compilation from the *Comptes Rendus*, the *Journal fur Praktische Chemie*, the *Journal of the Chemical Society*, &c.

The Atomic Weights of Copper, Zinc, and Nickel.—H. Baubigny.—From the *Comptes Rendus*.

The Equivalent Weight of Antimony.—J. Bongartz.—The author finds the equivalent of antimony (referred to O=7·9816) = 120·193; or, taking O=8, Sb=12.0·470

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome xi., April, 1884.

Report Presented by M. Bérard on behalf of the Committee of Chemical Arts on an Apparatus for the Production of Hydrogen by M. Egasse.—There is nothing novel in the inventors' principle of producing hydrogen, which is intended for the inflation of balloons.

Origin of the Combined Nitrogen Existing on the Surface of the Earth.—MM. A. Muntz and E. Aubin.—At the origin of the development of organised beings the authors consider there must have been a considerable stock of nitro-compounds. Perhaps we may attribute the luxuriance of vegetable and animal life in the geological epochs to this abundance of combined nitrogen, which in our times is rare and which must be added to the soil at great expense to increase its fertility. On this assumption it seems that we are living upon a stock of combined nitrogen produced at the beginning, and that we are liable to see this quantity decrease under the influence of the causes which restore to a gaseous state the nitrogen which has served in the formation of living beings unless the supply due to atmospheric electricity restores the balance.

Cosmos les Mondes.
No. 6, June 7, 1884.

Formation-Heat of the Sulphides and the Law of Thermic Constants.—Dr. D. Tommasi.—The author argues that M. Thomsen's determinations of the combining-heats of the neutral and acid sodium sulphites are inaccurate, and that the values more recently obtained by M. de Forcrand agree fairly with those calculated.

No. 7, June 14, 1884.

This issue contains no chemical matter.

No. 8, June 21, 1884.

The Transformation of the Theory of Atoms.—Victor Meyer.—A summary of the hypothesis of Prout and of the periodic system of Prof. Mendeleef and Lothar Meyer, Mr. Newlands being completely ignored.

No. 9, June 28, 1884.

The Existence of Manganese in Plants and its Part in Animal Life.—E. J. Maumené.—Already noticed.

No. 10, July 5, 1884.

This number contains no chemical matter.

No. 11, July 12, 1884.

Copper from a Sanitary Point of View.—Dr. H. George.—Copper possesses no general toxic action upon persons saturated with it; the slight troubles which it may induce are due merely to a local irritation. But on the other hand it does not confer on such persons any special immunity from epidemic diseases, and should not inspire any illusive security.

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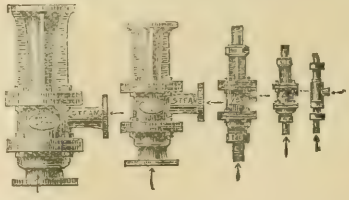

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THE CHEMICAL NEWS.

VOL. L. No. 1288.

NOTE ON EXAMINATION OF SNOW WATER.

By E. WALLER, Ph.D.

DURING the first snow-storm of the past winter (December 19th, 1883) some of the fresh fallen snow was collected and submitted to examination. As the results may be of some interest I beg to submit them.

The sample was collected in the yard at Columbia College after it had been snowing for some three or four hours, and snow was still falling. The ground was then covered to the depth of about 4 inches.

The snow was taken up without touching it with the hands, and placed in a large stoppered bottle, which was then closed and placed on the shelf in the laboratory until the snow had melted. It may be here noted that the surface beneath the spot from which it was taken was a gravelled walk. The examination of the water was conducted alter the larger particies of sand, coal from the engines on the 4th ave, &c. had settled out. The water was slightly turbid. The results were (in parts per 100,000):—

Chlorine	trace
Phosphates	none
Nitrates	none
Nitrogen in nitrates	0·0494
Free ammonia	0·0396
Albumenoid ammonia	0·0318
Hardness	0·91
Total solids	6·3

The sediment from the water was collected. While it was settling a slimy fungoid growth collected at the bottom of the vessel, which caused the sediment to adhere somewhat to the glass. To remove this the material was gently ignited and afterward examined under the microscope. The object aimed at was the identification, if possible, of particles supposed to have come from the Java volcano, Krakatoa, which have been asserted to exist in the snow, &c., which fell in the early part of the winter. A specimen of the volcanic ash known to have come from that volcano was also examined under the microscope at the same time. A one-fifth objective (Beck) was used. To my eye the only forms common to both the specimens were small, vitreous particles looking like broken up microscope covers.

I am, however, not familiar with the characters of volcanic ashes under the microscope, and may have missed what should be looked upon as characteristic. Judging from what was observed, it seems doubtful whether it could be safely asserted that the snow contained any particles which originally came from the volcano.—*Journal of the American Chemical Society.*

METHOD FOR THE ASSAY OF INDIGO.

By CHARLES TENNANT LEE.

THE determination of indigo blue, or indigotin, in indigo presents various difficulties. The processes in use are long, and subject to considerable error. The methods which depend upon the reduction and subsequent measured oxidation of indigo require the elimination, previously, of all other reducible bodies, to ensure accuracy—an operation both long and tedious. The me hod by formation of sulphindigotine and its estimation by a standardised permanganate solution, always gives too high results by reason of the presence of other oxidisable bodies.

For several years the author has used a method by sublimation, which has been uniformly satisfactory. Indigo blue sublimes readily, and, by a careful regulation of temperature, can be separated from the other components of indigo, indigo brown, indigo red, mucilaginous matter, &c.

The operation is best effected in a shallow platinum tray. Those in use are 7 c.m. long, 2 c.m. wide, 3 to 4 m.m. deep. Into such a tray is weighed about 0·25 grm. of finely-powdered indigo which has been dried at 100° C. The weighing should be rapid to avoid absorption of moisture, and it is best not to exceed this amount greatly for a tray of the size noted, in order that the layer of indigo may be thin.

Spread the weighed powder evenly over the tray by tapping it with the finger: this can be done easily if the bottom of the tray is quite flat, with no rounding towards the sides. Sublime on an iron plate, at first raising the heat gradually to avoid burning.

When the surface of the indigo is covered over with a shining layer of crystals, turn down upon the plate a piece of Russia iron bent into the form of a flat arch, the highest point of which is about 1 c.m. above the plate, and a little longer than the tray. Lower the heat at the same time that the arch is put on, as the temperature rises rapidly.

The purple vapours of indigotin are now given off, a portion condensing upon the under sides of the arch. Raise the heat slowly, and enough to maintain a constant sublimation of indigotin. By raising the arch the progress of the work is seen. For a 50 per cent indigo the time required is 30 to 40 minutes; but soft, Java indigo must be sublimed with more caution, and sometimes require two hours. The last crystals of indigotin are easily seen upon the dark coloured surface of the residue. When all have disappeared, remove the tray, cool in a desiccator, and weigh. The loss in weight is indigotin. Observe that the heat be no greater than is required to sublime the indigo blue; and that no yellowish vapours appear, which would indicate the destruction of the residue, leaving only ash.

If the bottom of the tray is flat and everywhere touches the plate, the sublimation goes on regularly except in case of very rich indigos, already mentioned, when care must be exercised to prevent burning.

Results by this method are constant within $\frac{1}{4}$ of 1 per cent, but the author has frequently made re-determinations with variations of only half that error.

A little practice enables one to leave the sublimation with only occasional attention, and three or four determinations may be carried on at once under the same arched cover.

For commercial and industrial purposes this method appears to have decided advantages. Its rapidity is in great contrast to the other methods which admit of perhaps two determinations in a day, while in point of accuracy it is not wanting.—*Journal of the American Chemical Society.*

Laboratory, 45, Kilby-street,
Boston, May 5, 1884.

DETERMINATION OF BORIC ACID IN BORO-SILICATES.

By C. BODEWIG.

THE determination of boric acid, as such, or in simple borates, involves, according to usual methods, no especial difficulties provided that pure reagents are employed, and especially hydrofluoric acid free from silica. More difficult is the determination if silica is simultaneously present. For the separation of both acids it is usual to fuse the mineral with four parts of alkaline carbonate, to lixiviate the melt first with pure water and then with water to which a drop of solution of ammonium carbonate has been

added, to wash and to precipitate the silica from the filtrate by means of ammonium sesquicarbonate or chloride.

The addition of ammonium sesquicarbonate is effected in such a proportion (2½ parts) that all alkaline carbonate is converted into bicarbonate. The ammonium carbonate formed is evaporated almost entirely away on a simmering water-bath, and the silica is washed with water to which a little ammonium carbonate has been added. A considerable proportion of silica remains in solution in the alkaline liquid, which after expulsion of all ammonium carbonate is precipitated by zinc oxide dissolved in ammonia as zinc silicate, all ammonia being expelled by heat. It is rarely practicable to remove all the silica by a single treatment of the alkaline solution. If the experiment is repeated with 10 c.c. solution of zinc oxide, and if the precipitate is dissolved in hydrochloric acid, the silica can be readily detected by the addition of ammonia in excess. It is unimportant whether the solution of zinc oxide is added to a concentrated or a dilute alkaline solution. A concentrated solution of alkaline carbonate (1 : 15) has, however, the disadvantage of dissolving zinc oxide in considerable quantity, whilst a solution of 1 : 50 does not dissolve zinc oxide. It is, therefore, preferable to remove the last traces of silica by diluting the solution to 1 : 50 and adding 10 c.c. solution of zinc oxide, driving off all ammonia, making good the loss of water and repeating the precipitation with zinc oxide a second time. Or the alkaline solution may be concentrated, solution of zinc oxide added until no further precipitate is produced in a filtered portion, diluted to 1 : 50 and then further treated as above. The precipitation is here also incomplete and a repetition is needful.

On repeated treatment with solution of zinc oxide a little zinc borate appears to be thrown down, as the results are too low.

If the alkaline solution is only once treated with zinc oxide, not only silica may remain in solution, but during the long evaporation of the alkaline liquid for the expulsion of ammonia, zinc silicate is dissolved.

From these reasons it is advisable to effect the separation of silica not by means of zinc oxide but with a quantity of ammonium chloride equivalent to the alkali employed. It must, however, be remembered that the separation of the silica is incomplete, and that the portion which remains dissolved must be determined in Marignac's method in the magnesium borate, or in Stromeyer's method in the potassium boro-fluoride.

The best process is the following:—To the solution of the alkaline melt, at a dilution of 1 alkali to 30 water, the necessary quantity of alkali is gradually added; the greatest part of the ammonium carbonate formed and the ammonia are evaporated off on a simmering water-bath, making good the escape of water if needful, filtered, and washed with water to which 1 drop ammonia is added per 50 c.c. If the alkaline solution mixed with ammonium chloride is evaporated to neutrality a little boric acid may easily be lost.

On treating sodium borate with ammonium chloride, there are formed sodium chloride and ammonium borate, which latter, on evaporation, is resolved into boric acid and ammonia. The solution containing sodium chloride, ammonium borate, and a little silica, is mixed with ammonium chloride, and so much crystalline magnesium chloride that its weight is fourteen times that of the boric anhydride expected, and the solution is evaporated to dryness, keeping it constantly ammoniacal. All the ammonium chloride is cautiously expelled, and the residue heated to redness, extracted with water, and washed. The filtrate is once more mixed with magnesium and ammonium chlorides and the operation repeated. The residues, consisting of magnesia, boric acid, magnesium chloride, and silica, are dried, carefully mixed in the crucible, moistened with water, dried, and strongly ignited. The moistening, drying, and ignition are again repeated to effect the destruction of the magnesium oxychloride. After weighing, the silica is determined in one-third of the mixture by dissolving in strong hydrochloric acid, drying at 120°, and extracting with hydrochloric acid; the magnesia is determined in the hydrochloric solution. In the residue of the magnesium borate the chlorine is determined, letting it stand for 12 to 24 hours in the cold in contact with concentrated nitric acid, when complete solution is effected. The liquid, after filtration, is mixed with an equal volume of water, and the chlorine is precipitated with silver nitrate.

In applying Stromeyer's method the excess of ammonium carbonate added to the solution of the melt of potassium carbonate is destroyed by potassa lye, adding such a quantity that 2 mols. potassium hydroxide come to 1 mol. boric anhydride; hydrofluoric acid is added in excess so that litmus paper is reddened, the liquid is evaporated to dryness, and the process is completed as directed by Fresenius ("Quantitative Analysis," 6th edition, vol. i.).

The potassium boro-fluoride obtained contains potassium silico fluoride. This potassium silico-fluoride cannot, as it is sometimes stated, be removed by evaporation with ammonia. For its determination the method of precipitation with an ammoniacal solution of zinc oxide is used, as recommended by Berzelius.

The author has examined the volumetric method for the determination of boric acid as proposed by E. F. Smith, and is not satisfied with the results.—*Zeitschrift fur Analytische Chemie.*

EXTRACTION OF PHOSPHORIC ACID FROM THE SLAGS OF THE THOMAS AND GILCHRIST PROCESS.

By Dr. C. SCHEIBLER.

The slags obtained in Westphalia by this process contain 4½ to 8½ per cent silica, 9 to 14 iron, chiefly in the ferrous state, 17 to 21 phosphoric acid, and 47 to 52 lime. If it is found practicable to separate the phosphoric acid in the form of calcium phosphate, and to eliminate the silica from the residue of the slag, the remainder, consisting chiefly of oxides of iron and manganese, and of lime and magnesia, will prove an excellent material for the production of manganiferous irons and for other technical purposes. The method used at Schalke and Stolberg aims at this decomposition of the slags into biphosphate and into manganiferous iron oxides. For this purpose it is necessary in the first place to convert the ferrous and manganous oxides into the corresponding ferric and manganic salts by a process of roasting, in a current of air, and thus to make them less liable to the action of acids, at the same time to destroy the iron and calcium sulphides present in the slags by oxidation.

At Schalke the slags are roasted in reverberatories with a sloping double sole 9 metres in length by ½ in breadth' which allow of a complete utilisation of the heat. The consumption of coal is trifling. For roasting 1000 kilos. slag there are required 100 to 130 kilos. of coal, and such a furnace roasts in twenty-four hours 15 to 17,500 kilos. of slag.

The slag is finely pulverised either before or after roasting. The comminution of the greater part of the roasted slags is easily effected by treating them with steam, whereby the quicklime contained in the slags is converted into hydrated lime, which effects the mechanical disintegration of the slags into a fine powder. Portions which resist this process may be pulverised by disintegrators.

The granules of steel are separated by sifting, or by means of magnets. From the finely pulverised slag the earthy silicates and the calcium phosphate are extracted by means of very dilute acids. This dilution is necessary to prevent the coagulation of the silica, so that the solutions may be easily separated from the residues by

filtration or decantation. Hydrochloric acid is to be preferred, as sulphuric acid occasions inconvenience by the formation of gypsum, which envelopes the particles of slag. At Schalke 1180 to 1250 kilos. hydrochloric acid at 30° Tw. are used for working up 1000 kilos. slag. The consumption of acid may be further reduced by previous lixiviation with water, which dissolves out free lime.

The process of solution is completed in a few minutes. The operation is conducted in stirring-tanks, and on settling the solution is run off from the solid residue, which is then stirred up and washed with a still weaker acid.

The solutions are neutralised with milk of lime in large stirring-tanks so far that either all the phosphoric and the silicic acid are thrown down as bicalcic phosphate and calcium silicate, or only so far that only the phosphoric acid and a small part of the silica are thrown down, the bulk of the silica remaining in the clear mother-liquor.

To separate the phosphatic mud from the liquid large filter-presses are used, filled by self-acting pumps. The press-cakes contain 65 to 70 per cent of water.

The drying of the cake is effected at Schalke and Stolberg by means of a mechanical apparatus which pulverises it at the same time. The dry product contains 34 to 38 per cent phosphoric acid, 6 to 8 silica, 28 to 32 lime, and 1½ to 2 sulphuric acid, along with small quantities of chlorine, ferric and manganic oxides, &c.

On an average 50 per cent of the weight of the slag is obtained as a powder of the above composition. These lime precipitates are well adapted for agricultural processes in virtue of their fine state of division and of their high percentage of phosphoric acid.

The residue amounts to about 30 per cent of the gross weight of the slag, and when dried at 100° contains—silica, 1·5 to 5 per cent; phosphoric acid, 0·3 to 4; ferric oxide, 43 to 69; manganic oxide, 10 to 17; lime, 5 to 16; magnesia, 7 to 13. Hence these residues are especially adapted for producing crude irons rich in manganese. Their value is increased by the presence of the alkaline earths, which admits of their admixture with acid ores without any further addition of lime.—*Berg. und Hutten. Zeitung.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

PLATINUM.

FOR this metal we have to consider only experiments by Berzelius, by Andrews, and by Seubert. In an early paper Berzelius† reduced platinous chloride, and found it to contain 73·3 per cent of platinum. Hence, Pt = 194·204, a value very near that obtained most recently by Seubert. In his later investigations, Berzelius‡ studied the potassium chloroplatinate, K_2PtCl_6. 6·981 parts of this salt, ignited in hydrogen, lost 2·024 of chlorine. The residue consisted of 2·822 platinum, and 2·135 potassium chloride. From these data we may calculate the atomic weight of platinum in four ways:—

1st.	From loss of Cl upon ignition	Pt =	197·722
2nd.	,, weight of Pt in residue	,,	196·942
3rd.	,, ,, KCl ,, ...	,,	196·215
4th.	,, ratio between KCl and Pt	,,	196·652

The last of these values is undoubtedly the most reliable, since it involves no errors due to the possible presence of moisture in the salt analysed. If O = 16, the value becomes Pt = 197·104.

The work done by Andrews* is even less satisfactory than the foregoing, for the reason that its full details seem never to have been published. Andrews dried potassium chloroplatinate at 105°, and then decomposed it by means of zinc and water. The excess of zinc having been dissolved by treatment with acetic and nitric acids, the platinum was collected upon a filter and weighed, while the chlorine in the filtrate was estimated by Pelouze's method. Three determinations gave as follows for the atomic weight of platinum:—

197·86
197·68
198·12

Mean 197·887

If we assume that these values were calculated with K = 39 and Cl = 35·5, the mean, corrected by our later figures for these elements, becomes Pt = 197·382. If O = 16, this becomes Pt = 197·836. Unfortunately, Andrews does not, in his brief note upon the subject, indicate the manner by which his calculations were made.

Latest of all we have to consider the experiments of Seubert.† This chemist prepared very pure chloroplatinates of ammonium and potassium, and from their composition deduced the atomic weight of the metal under consideration. The ammonium salt, $(NH_4)_2PtCl_6$, was analysed by heating in a stream of hydrogen, expelling the excess of that gas by a current of carbon dioxide, and weighing the residual metal. In three experiments the hydrochloric acid formed during such a reduction was collected in an absorption apparatus, and estimated by precipitation as silver chloride. Three series of results are given for the percentage of platinum in this salt, together with another single result which may be considered alone. Here are the figures:—

Series I.	Series II.	Series III.
43·957	43·871	43·990
43·948	43·876	43·986
43·960	43·872	44·001
43·946	43·881	44·020
43·963	43·875	43·994
43·961	43·879	43·996
		44·004
Mean 43·956 ± 0·002	Mean 43·876 ± 0·001	44·026
		43·998

Mean 44·001 ± 0·003

These series represent three preparations. The additional single experiment above referred to was made with material belonging to series II., but re-crystallised from water. This salt gave 43·955 per cent of platinum, a figure to which we may assign the probable error of one experiment in the first series. Combining, we get the subjoined general mean percentage of Pt in $(NH_4)_2PtCl_6$:—

Series I.	43·956	± 0·002
,, II.	43·876	0·001
,, III.	44·001	0·003
Extra experiment	43·955	0·004
General mean ..	43·907	0·0009

Hence Pt = 194·314 ± 0·078. If N = 14. and Cl = 35·5, then Pt = 194·906. Calculating with Stas's values for N and Cl, Seubert gets from the four results combined above, the following figures for Pt, respectively:—194·685, 194·039, 195·034, 194·665.

For the chlorine estimations in the ammonium salt the subjoined weighings are given:—

Salt.	Pt.	AgCl.
2·7054 grms.	1·1871 grm.	5·2226 grms.
2·2748 ,,	0·9958 ,,	4·3758 ,,
3·0822 ,,	1·3561 ,,	5·9496 ,,

* Smithsonian Miscellaneous Collections. The Constants of Nature."

† *Poggend. Annal.*, 8, 177. 1826.

‡ *Ibid.*, 13, 468. 1828.

† *British Association Report*, 1852. *Chem. Gazette*, 10, 380. *Ber. der Deutch. Chem. Gesell.*, 14 865. 1881.

Hence 100 parts of AgCl correspond to the following quantities of salt:—

51·802
51·986
51·805

Mean 51·864 ± 0·041

Hence, calculating directly from the ratio between 6AgCl and $(NH_4)_2PtCl_6$, Pt = 196·871 ± 0·363.

Seubert himself reckons the percentage of chlorine from the weight of silver chloride, and then calculates the ratio between Cl_6 and Pt. He thus finds, with Stas's value for Cl, Pt = 195·330.

The potassium salt, K_2PtCl_6, was also analysed by ignition in hydrogen, treatment with water, and weighing both the platinum and the potassium chloride. These percentages were found:—

Pt.	KCl.
40·119	30·706
40·120	30·728
40·076	30·698
40·070	30·666
40·107	30·700
40·120	30·627
40·114	30·710
40·130	30·621
Mean 40·107 ± 0·005	Mean 30·682 ± 0·009

From the first column .. .. Pt = 194·370 ± 0·068
„ second „ .. .. „ 194·645 0·213

If K = 39, and Cl = 35·5, the first column gives Pt = 194·933. Seubert, from the percentage of platinum, gets Pt = 194·392; and from the ratio 2KCl : Pt he finds Pt = 194·494.

As with the ammonium salt, three experiments were made upon the potassium compound to determine the amount of chlorine lost upon reduction in hydrogen. I cite the weighings, and add in a fourth column the quantity of K_2PtCl_6 proportional to 100 parts of AgCl. This AgCl represents but *four* atoms of the chlorine:—

Salt.	Pt.	AgCl.	Ratio.
6·7771 grms.	2·7158 grms.	7·9725 grms.	85·006
3·5834 „	1·4372 „	4·2270 „	84·774
4·4139 „	1·7713 „	5·2144 „	84·648
		Mean	84·809 ± 0·071

Hence Pt = 195·002 ± 0·415. If K = 39, Ag = 108, and Cl = 35·5, then Pt = 194·955. Seubert, calculating the percentage of chlorine and thence the ratio Cl_4 : Pt, gets Pt = 194·631.

Combining all the values we have the following result for the atomic weight of platinum:—

1. From p. c. Pt in $(NH_4)_2PtCl_6$ ..	Pt = 194·314	±	0·078
2. „ 6AgCl : $(NH_4)_2PtCl_6$ ratio..	„ 196·871		0·363
3. „ per cent Pt in K_2PtCl_6 ..	„ 194·370		0·068
4. „ „ KCl „ ..	„ 194·645		0·213
5. „ 4AgCl : K_2PtCl_6 ratio ..	„ 195·002		0·415
General mean	„ 194·415		0·049

Or, if O = 16, Pt = 194·867.

Seubert, taking the arithmetical mean of his eight values, gets Pt = 194·620. He regards, however, those results as best which are dependent upon the percentage of platinum in the ammonium salt, and upon the complete analysis of the potassium compound. These give him a mean of Pt = 194·461, which, if corrected by reduction to a vacuum standard, becomes Pt = 194·34.

It will be noticed that three of the ratios, calculated with K = 39, N = 14, Ag = 108, and Cl = 35·5, give nearly Pt = 195, namely:—

194·906
194·933
194·955

The general mean of all, if O = 16, gives Pt = 194·867.

Hence, for all practical calculations, the value 195 may be safely employed.

PROCEEDINGS OF SOCIETIES.

SOCIETY OF CHEMICAL INDUSTRY.

Newcastle-on-Tyne, July 9th, 1884.

Address delivered at the Third Annual General Meeting by the Retiring President, WALTER WELDON, F.R.S., &c.:—

(Concluded from p. 44).

THE two questions which I asked some time ago I have now answered. Clearly, the Leblanc process is not destined to remain our only means of obtaining hydrochloric acid, and for my own part I can have no doubt that the use of hydrochloric acid as the immediate raw-material of the chlorine manufacture is also one of those things in respect of which the old order must,—partially, at any rate,—give place to new.

And I ought to add that the processes for the obtainment of chlorine and hydrochloric acid in connection with the manufacture of ammonia soda which I have mentioned are not the only processes to those ends which are in the field. Within the last few weeks M. Solvay has taken three more patents for such processes, and quite a number of other workers at the problem of obtaining chlorine or hydrochloric acid from calcium chloride now consider that they are on the verge of success.

While, however, it is now quite certain that chlorine will be manufactured at least from magnesium chloride, one can hardly conceive that its manufacture from either magnesium chloride or calcium chloride can ever more than partially displace its manufacture from hydrochloric acid, whatever changes may take place in our mode of obtaining hydrochloric acid. I come now, therefore, to the question of the utilisation of hydrochloric acid in the chlorine manufacture more completely than it is utilised therein at present, a question upon which the continued existence of the Leblanc process certainly now mainly depends.

The present Weldon process, even when performed to the very best advantage, does not yield more than one-third of the total chlorine of the hydrochloric acid treated by it, the other two-thirds of that chlorine being lost as calcium chloride. It is thus unquestionably a barbarous process. It met well enough the wants of the time when hydrochloric acid could be counted as having no value, and when the two problems in respect of the chlorine manufacture which pressed to be dealt with were simply those of how to diminish the then chief item of the cost of chlorine,—that for native manganese,—and how to keep the offensive residual product of the treatment of that native manganese by hydrochloric acid out of the water-courses; but it is no longer equal to the production of cheap bleaching-powder, now that the value of hydrochloric acid has become such that the bleaching powder produced by it costs more for hydrochloric acid than for all other items of its cost put together. For some years past, therefore, many inventors have been endeavouring to devise a hydrochloric acid chlorine process which should yield in the free state practically the whole of the chlorine of the acid treated by it; and a process which I believe will do this is one of the group of processes to the endeavour to realise which MM. Pechiney et Cie. have for some time past been devoting not only vast material resources,

but a power of overcoming the practical difficulties which are always encountered in attempts to work out new industrial chemical processes, of which I have known no parallel.

The process in question is simply a new form of a very old idea. Its first operation consists in digesting with aqueous hydrochloric acid an oxide of manganese which has been regenerated from manganese chloride in the dry way. There are thus obtained undiluted chlorine and a residual solution of manganese chloride. The latter is then evaporated to dryness, and the solid manganese chloride so obtained is then heated in intimate contact with atmospheric oxygen. The chlorine of the manganese chloride is thereby driven off in the free state,—mixed, of course, with other gases,—and its manganese obtained as an oxide, rich in oxygen, with which to re-commence the round of operations. Per given quantity of hydrochloric acid treated by it, the process yields practically the same quantity of strong chlorine as can be obtained from the same quantity of acid by means of Weldon mud, together with something over twice that quantity of chlorine diluted by other gases.

I shall, certainly, at least not be above the mark if I take the consumption of hydrochloric acid, per ton of bleaching-powder made by the present Weldon process, at the quantity the production of which by the Leblanc process, together with the quantity of soda which must be produced at the same time, costs £5 more than the cost of producing by the ammonia process the equivalent of that quantity of Leblanc soda; or, in other words, at the quantity corresponding to 5 tons of aqueous hydrochloric acid of 27 per cent. I know of no instance in England in which a ton of Weldon bleach is obtained per less than 5·7 tons of such acid; but I propose to assume that a ton of bleaching-powder can be made, by the present Weldon process, per the quantity of acid the present minimum cost of which is £5.

The other items of the cost of a ton of bleaching-powder, made by that process,—apart from lime for the chambers, labour on the chambers, casks, packing, and general charges,—are those for lime for the oxidisers, limestone or chalk for the wells, manganese to make up loss, fuel, labour on the stills, and labour on the regeneration process. I believe that the sum of these items averages about 19s.; bringing up to about £5 19s. that part of the expense of manufacturing a ton of bleaching-powder by the present Weldon process which represents the cost of that ton of bleaching-powder for chlorine only.

The process which is now on the point of being got to work at Salindres, after much experience of it on a semi-industrial scale, requires neither lime nor limestone, nor does one see how there can be any appreciable loss of the manganese employed in it. The loss of manganese incurred in the present Weldon process is mainly due to impurities which are constantly entering that process, and have to be continually eliminated and thrown away, and with which it is impossible to avoid throwing away more or less manganese; but in the new process in question there is nothing to throw away. Its cost is thus simply for acid, fuel, and labour.

That that process is capable of yielding the quantity of chlorine corresponding to a ton of bleaching-powder, per quantity of hydrochloric acid corresponding to less than 30 cwts. of acid of 27 per cent, is already sufficiently demonstrated. The value of that quantity of acid being taken at £1 10s., there remains £5 19s. less £1 10s., or £4 9s., out of which to pay simply the cost of evaporating to dryness a quantity of solution of manganese chloride containing 1¾ tons of water, and then treating by heat and air something less than 15 cwts. of manganese chloride mixed with a certain proportion of manganese oxide. The advantage of the new process over the old one, per ton of bleaching-powder manufactured, will be the balance left after deducting from those £4 9s. the cost of these two operations.

The difficulties which have been encountered in the endeavour to realise this process have been mainly with respect to the apparatus and mode of working by which to effect the often proposed reaction of atmospheric oxygen upon manganese chloride. Manganese chloride is a somewhat readily fusible salt; oxygen does react upon it below its fusing-point, but only slowly: for the reaction to go on sufficiently rapidly the temperature employed must be above the fusing-point of the manganese chloride, and the latter must present to the air by which it is treated a very considerable surface; while a fused mass of manganese chloride not only presents far too small a surface, but is destructive of all materials of which apparatus for treating it industrially could be formed.

For the treatment of manganese chloride, as of magnesium chloride, the principle adopted at Salindres is that, to which I have already referred, of mixing the chloride to be treated by heat and air with an oxide of the same metal, the main function of the oxide being to mechanically divide the chloride, so as to permit of the chloride being heated to above its fusing-point, without the mass treated becoming fluid or ceasing to be penetrable by air. I will not stay to describe the various ingenious appliances which MM. Pechiney et Cie. have successively devised for the performance of the operation of treating by heat and air mixtures of manganese chloride and manganese oxide; but will only add that I believe that they have now completely overcome all the many difficulties which for a long time seemed to render the industrial realisation of that operation almost hopeless, and that it now seems certain that they will soon be manufacturing chlorine from the hydrochloric acid of the Leblanc process at the rate of the quantity of chlorine corresponding to a ton of bleaching-powder per little more than 14 cwts. of salt.

Given this result—a result diminishing by two-thirds the quantity of Leblanc soda necessary to be manufactured in order to the manufacture of a given quantity of chlorine from Leblanc hydrochloric acid—will it enable the Leblanc process, thus shorn of its proportions, to continue to live, in face of the decomposition by magnesia of the ammonium chloride of the ammonia process, and the direct obtainment from the resulting magnesium chloride of one-half of its chlorine in the free state? I trust that this may be so; but, as yet, the data for a conclusion on the point are insufficient, and of those of them which as yet exist, some tell one way, and some the other. The manufacture of chlorine from magnesium chloride, obtained by decomposing by magnesia the ammonium chloride of the ammonia process, involves much more evaporation than is required for the manufacture of the same quantity of chlorine from hydrochloric acid by the process to which I have just referred; and the whole of the chlorine obtained by the former process is diluted by other gases, whereas one-third of the chlorine obtained by the latter process is undiluted. On the other hand, the degree of dilution of the chlorine obtained from magnesium chloride is somewhat less than that of the chlorine obtained from manganese chloride; and to decompose magnesium chloride, or rather magnesium oxychloride, by heat and air, is somewhat easier than to decompose maganese chloride by the same means. All that is yet clear in the matter therefore is that chlorine will be manufactured in connection with the ammonia process, though perhaps not to any appreciable extent for a few years yet. But the question which, in face of that certainty, it is impossible not to ask: the question of whether it is or is not likely that the greatest chemical invention of the eighteenth century, if not indeed of any century, shall have ceased by the end of the nineteenth to be anything more than a tradition and a name, as yet it is equally impossible to answer.

If, however, unfortunately, that question shall be eventually answered in a sense adverse to those whose capital is invested in the Leblanc process: must the manufacture of soda disappear from Tyneside? It was on Tyneside that "artificial soda," as it used to be called, was first manufactured in England. Must, in such case, this district know that industry no more? I am not of that

opinion. At present, the manufacturer of ammonia soda from brine employs, per ton of soda manufactured, from a ton and a quarter to a ton and a half of coal, and the quantity of brine containing about forty-six hundredweight of salt. His coal consumption is thus light, but the quantity of salt which he consumes is twice the quantity equivalent to the soda he manufactures. Any method, however, of obtaining, either as free chlorine or as hydrochloric acid, the chlorine of the salt decomposed by the ammonia process, must necessarily involve the evaporation of all the water employed in that process,—during which evaporation that portion of the salt employed in it which at present escapes utilisation will be recovered,—and must moreover involve a subsequent operation, also requiring an expenditure of fuel. Any such method must thus reduce to absolutely its theoretical amount the quantity of salt consumed in the ammonia process, per unit of soda manufactured thereby, reducing it to one-half the quantity at present required by the manufacturer of ammonia soda from brine, but must at the same time increase his consumption of coal, per unit of soda, by at least between one hundred and two hundred per cent. Under such changed conditions—at any rate when Cleveland salt shall have become obtainable here at a cost not much greater than that of Cheshire salt in Lancashire—I think it ought to be possible to manufacture ammonia soda in this district very nearly if not quite as cheaply as in any other locality whatever.

It is not willingly that I have announced a new—and much more serious than any previous—menace to an industry already sorely tried. How much I should have preferred to have been able to prophesy smooth things with respect to the Leblanc process no words can say. Facts, however, must be looked in the face. Nothing can be less wholesome than the atmosphere of a fool's paradise. And the watch-dog at the gate, who gives timely notice of the approach of unwelcome visitors, at least renders such service as is in his power.

But if such changes as that which I have indicated as now certain to be accomplished at least partially are unwelcome, it is only in so far as they may affect individuals. By such changes individuals may, and alas! do suffer; but the world gains by them. No industrial process is ever superseded, however partially, excepting by a better process. And in so far as the Leblanc process may be doomed to still further restriction, it can only be because some other process can give mankind cheaper soda and cheaper chlorine than it can give.

And the various proposed new processes of which I have spoken all comply with at least one of the ideals towards which all progress in such matters must henceforth tend. They all possess in common one feature which will certainly be held essential to all industrial chemical processes in a not distant future. They are all processes yielding no waste product. They are all processes completely utilising all the constituents of all their raw materials. Excepting coal and water, nothing would be manipulated in any of them which was not finally yielded either as commercial commodity, or as regenerated reagent for use again. That way certainly lies the future.

Amongst the many transcendent merits of the beneficent invention of Nicholas Leblanc, of immortal memory, that of yielding no waste product is not included. There are spots on the sun; and the Leblanc process yields alkali-waste. Countless have been the efforts to utilise at least one of the constituents of that residue; but none of them have fully succeeded. Now, however, ninety-seven years after the invention of the process to which we chiefly owe that soap, and glass, and paper, and countless other commodities only less useful than these, have been placed within the reach of all mankind; seventy-four years after its inventor, "the creator," as Hofmann puts it, "of incalculable wealth for his species," put an end to his existence because he wanted bread, which makes it so pleasant to know that two generations afterwards he at least received a stone-statue, towards the erection of which, however, I have yet to learn that any English soda maker contributed. Now, when one cannot but fear that the long day of the Leblanc process may be tending towards its close, a means of utilising both the principal constituents of that residue seems almost in sight. To speak now of the recovery of sulphur from Leblanc soda-waste may seem a kind of anti-climax; but the gallant attempt to realise the Schaffner and Helbig process to that end upon which Mr. Alexander Chance recently expended so much enthusiastic effort, and the firm of which he is a member the greater portion of £10,000, has not only resulted in a reduction in the price of pyrites, but also in the suggestion of various other processes for the accomplishment of the same object: to a conceivable combination of certain parts of some of which I would ask permission to devote a very few concluding sentences.

The combined process in question would commence by bringing the calcium sulphide of alkali-waste into solution as calcium sulphydrate, by treating a mixture of waste and water by sulphuretted hydrogen. The second operation would consist in evaporating the resulting solution of calcium sulphydrate, and so driving off its sulphur as pure H_2S; and the third and final operation in burning off the hydrogen only of that sulphuretted hydrogen, setting its sulphur free.

The third of these operations has for some time past been under experiment in the works of Messrs, Chance Brothers, at Oldbury. The apparatus used in it is one invented by Mr. C F. Claus, of London, and consists of a kiln in which there is a deep bed of fragments of porous material, through which, when the apparatus is at work, there is passed a mixture of sulphuretted hydrogen with a carefully regulated quantity of air. The bed of porous material is maintained at a high temperature by the heat of the reaction which takes place as the mixture of gases passes through it, and from the mixture of gases and vapours passing off from it sulphur condenses as that mixture cools. The operation thus costs nothing for fuel, and its cost for labour is scarcely more than the cost of from time to time removing sulphur from the receptacles in which it has condensed and collected.

The first of the three operations is in industrial operation at Rassuen, in the South of France, in connection with a most ingenious process, invented by M. Lombard, of Marseilles, in which calcium sulphydrate is used to precipitate dicalcic phosphate from the solution obtained by dissolving native calcium phosphate in hydrochloric acid. It is also in operation, on a semi industrial scale, in the alkali work of Hrüschau, in Moravia. Its cost is simply that of charging waste and water into horizontal cylinders furnished with mechanical agitators, keeping these agitators in motion during the operation, and at the end of the operation discharging the contents of the cylinders.

The second of the three operations is under experiment at Hrüschau, by Dr. Heinrich von Miller and Herr Opl. This second operation is obviously more costly than the first or third; but it yields, in addition to sulphuretted hydrogen, another product, which other product, it is hoped, may pay nearly if not quite the whole cost of the three operations. This other product is chemically pure calcium hydrate—resulting from the reaction—

$$CaH_2S_2 + 2H_2O = CaH_2O_2 + 2H_2S.$$

Unlike the recovered calcium carbonate of the Schaffner and Helbig process, this calcium hydrate can be readily obtained absolutely free from impurities, since no impurities precipitate with it, and its physical condition is such that water or a solution runs from a heap of it almost as readily as from so much sand. It is incapable of causticising solutions of sodium carbonate more than partially; it is too dense for use in Weldon oxidisers; but it seems not unlikely to prove suitable for use in bleaching-powder chambers. If it should prove to be the case, on the one hand, that this dense crystalline calcium hydrate shall have the value of an equivalent quantity of ordinary lime, and, on the other hand, that the hydrogen of sulphuretted

hydrogen can be oxidised, practically completely, without at the same time oxidising any appreciable proportion of its sulphur, then I think that an almost ideally perfect solution of the problem of the utilisation of the residual product of the Leblanc process will at last have been reached. If this should be so, one can only hope that that solution will not have arrived too late.

NOTICES OF BOOKS.

Annual Report of the Chief Engineer of the Philadelphia Water-Department for the Year 1883. Philadelphia: Dunlop and Clarke.

We have often had occasion to remark that in the United States, as population becomes more dense and manufactures increase, the supply of water for domestic purposes must become complicated, as it has been the case in England. Fortunately, most of the large American towns have shown, in this respect, a disposition to be wise in time. The necessity of a pure water supply is fully admitted, not merely in theory, but also in practice.

In the volume before us we meet with much from which the ratepayers of London may draw instruction. The water-supply of Philadelphia, like those of most other large American cities, is in the hands of the municipality. We find it remarked that among the various methods of charging for a water supply, "that of actual measurement is undoubtedly the most equitable, convenient, and direct," whilst the "rateable assessment" and "dimensions" plans are artificial means of averaging charges which are manifestly inequitable.

The Philadelphia water-supply is drawn partly from the Delaware and partly from the Schuylkill. One of the pumping-stations on the Delaware, that at Kensington, gets the full benefit of all the city-sewage, and in addition the Aramingo Canal, an open sewer of large dimensions and choked with filth, discharges in its immediate vicinity. Under these circumstances it is only natural that the water should be pronounced utterly unfit for human consumption.

The Schuylkill is less polluted, but it is still described as the natural sewer for a population of 350,000, largely engaged in manufactures. Here, accordingly, intercepting sewers are proposed. The author is of opinion that "it will be years before the sewage-saturated soil underlying a long-inhabited area and filled with cess-pools, can free itself from poisons." We are by no means sure that where the pollution has been extensive, even a century would suffice, especially in the case—to which the writer refers—of intra-mural graveyards.

Concerning the benefits to be derived from filtration, very judicious views are expressed. It is stated that the river when muddiest from a recent freshlet is probably in its most wholesome condition. . . . It is true that the passage of water through a mass of spongy iron has been found to oxidise in part the organic matter, but the cost of inaugurating a plant of this sort is too formidable to contemplate. . . . When all was done the organic (organised ?) matters would still remain, and it is these which constitute the real danger.

To our readers the most interesting portions of this volume will doubtless be the preliminary report by Dr. A. R. Leeds into the present and proposed water supplies of Philadelphia, and his final report to the Board of Experts. In his account of the analytical processes adopted he refers to a difference between the two methods of oxidising the organic matters by potassium permanganate and by the so-called "actinic" method, *i.e.*, the reduction of silver nitrate. The amounts of oxygen required, as determined by the latter process, are generally somewhat the lower. The indications of the oxidisable organic matter thus obtained follow along more closely with the relative amounts of putrescible nitrogenous matter than those obtained by the permanganate. Of course nitrites, oxidisable metallic salts, and sulphides interfere with the actinic method, but they also affect the permanganate process.

Dr. Leeds does not regard nitric acid as an index of previous sewage contamination unless the other analytical data point to the presence of foreign matters of animal origin. Neither can he accept chlorine as indicative of pollution unless either analytical or other testimony prove that it is derived from foreign matters of animal origin or from industrial refuse. He points out that "chlorine and salt are as constant constituents of the atmosphere as of river and ocean waters. . . . A large percentage of the chlorine in river waters must be regarded as coming from the sky and not from the ground."

The progressive absorption of oxygen, he contends with perfect justice, indicates progressive contamination. "It matters not to what extent the oxygen is used up by a direct chemical process of oxidation, and to what extent through the living agency of bacteria and micrococci in presence of decomposing organic matter."

A remarkable circumstance here discussed is that the water of the Schuylkill in January, 1883, became remarkably offensive to taste and smell. The odour was so persistent as to communicate a bad taste to articles of food cooked in the water, and to diffuse itself through houses. At the same time, the albumenoid ammonia found in the water was not greater but smaller than at other times of the year when no offensive smell or taste were complained of. Dr. Leeds considers that the stream being at that time entirely covered with ice, offensive gases accumulated—it was indeed proved that on breaking the ice marsh-gas was found in sufficient quantity to be ignited. The sulphates present in the river underwent reduction, forming hydrogen sulphide and sulphuretted hydrocarbons. During the time when the water was worst, it had an alkaline reaction.

It is well known that the purer a water is from organic pollution, the more its colour, when viewed through a long glass tube with proper precautions, approaches to a blue. We understand—though the fact is not mentioned in the work before us—that the potable waters supplied to most American cities do not exhibit this feature. This is a point which requires further investigation, since, according to European observations, the absence of the blue tint should indicate organic pollution.

We find here an abstract of the observations made by M. Gerardin on the river Vesle, above and below Rheims. In his results there is one point with which we cannot agree. Above Rheims he finds the water clear, wholesome, and containing abundance of fish, charas, *water-cress*, &c. At some distance below the city, we are told, "all traces of pollution had disappeared and fish and *water-cress* flourished. Now water-cress grows luxuriantly in polluted waters and even in raw sewage.

We are happy to find that Dr. Leeds takes into due consideration not merely the character of polluting materials entering a river, but their volume, and the proportion which they bear to the volume of water flowing in the river. The non-recognition of this evident principle was the fatal defect in the celebrated "recommendations" of the late Royal Rivers Pollution Commission. Had a law been founded upon those recommendations, any person who wished to run filth into a river could easily have evaded its provisions by diluting the offensive liquid so as to come within the letter of the law, though the river would have been polluted just the same.

Dr. Leeds must be recognised as one of the highest authorities on all chemical and sanitary questions connected with the water-supply of towns.

Platinised Magnesium as a Reducing Agent.—M. Ballo.—Magnesium, which has no action upon pure water, decomposes it instantly in presence of a trace of platinum chloride.—*Zeit. f. Anal. Chem.*

CORRESPONDENCE.

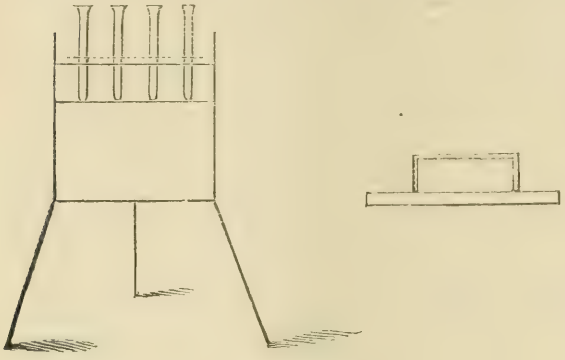
NEW CARBON BATH FOR THE EGGERTZ COLOUR TEST.

To the Editor of the Chemical News.

Sir,—I was very much interested in Mr. Arnold's description of a new bath for carbon estimation by colour test, but at the same time could not see any improvement upon a properly constructed copper one; in fact, should consider it a great source of danger, being made of glass.

The following is a sketch of a copper one I have had in use for nearly 11 years, without suffering any of the troubles mentioned by Mr. Arnold.

It is $7\frac{1}{2}$ inches in diameter, and contains holes for 32 samples, which numbers I have had regularly every day. It will answer equally as well for one as for 32 samples.



As will be seen, there is a lid with handle, which is removed when the water boils, and the tubes are then placed in the different holes—every tube being labelled, preferring that to having numbers stamped on plate, and taking scarcely any time—resting on a second plate with holes, but not large enough to allow of the tubes passing through; therefore they are perfectly upright, and remain in that position the necessary time, the water boiling.

As regards the objections mentioned by Mr. Arnold.

(*a*). It soon gets dirty, &c. Very slightly, and if so, a little oily waste will soon remove it; or have it japanned.

(*b*). The slanting position of tubes, &c. They are not slanting.

(*c*). The water in the bath is out of sight, &c. Certainly not; it never should be allowed to get below the top plate.

(*d*). The identity of tubes may be lost by slip of memory, &c. It would be very unwise for anyone to attempt to remember them, and using the small gummed labels dispenses with that.

(*e*). The bath frequently leaks, &c. That is entirely due to bad workmanship, I never having been troubled with it.

I notice Mr. Arnold marks two holes, s, for standards, as though every day he made standard solution. I mention this because I have heard that it is done in Sheffield by some chemists, but beg to say it is entirely unnecessary; for a properly-prepared standard solution of burnt sugar and water in a hermetically-sealed tube will keep for years; but of course it must be occasionally checked to see that it is right, my own not having been renewed for several years. In this bath there is no bobbing up of the tubes, they remaining perfectly steady as placed in the bath.—I am, &c.,

James E. Kelsall.

Laboratory, Bolton Steel and Iron Works,
Bolton, July 22, 1884.

FREEZING APPARATUS.

To the Editor of the Chemical News.

Sir.—I have read in one of our papers of a new discovery by M. Cailletet in freezing apparatus, which from its description appears to be simple and inexpensive, such an apparatus as could be sent to any of our fishing stations for the freezing up of bait, &c. I shall feel extremely obliged if you will inform me of any apparatus which can be worked without the aid of steam power, or rather by manual labour alone. I need scarcely say the object is to keep bait frozen in any given chamber without the use of ice and similar expensive means, which prevent our fishermen from availing themselves of bait thus secured on account of cost.—I am, &c.,

G. C. Fearn.

178, Water Street, St. John's, Newfoundland,
July 16, 1884.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

Sir,—I may perhaps be permitted to criticise a statement quoted by one of your reviewers in the Chemical News, vol. l., p. 30, which I have just received. The quotation to which I take exception is from Lieut.-Col. Ross's new work on "Blowpipe Analysis," and runs:—"It (*i.e.*, blowpipe analysis) is still untaught at the Royal School of Mines." To this extraordinary statement your reviewer adds, with perfect justice:—"Comment is here surely needless."

I happen to have the best possible reasons for knowing that the statement is entirely erroneous, for during the whole time I was a student at the school, viz., from 1880 to 1883, "Blowpipe Analysis" *has* formed part of our curriculum—though *not* as a distinct subject with a separate Professor, as Lieut.-Col. Ross would probably wish to see it.

I hope this gentleman will understand that I do not write this letter out of any spirit of discourtesy to him, but simply to ensure that such an inaccurate and injurious statement should not be allowed to spread without a disclaimer from someone who has a right to contradict it. I enclose my card.—I am, &c.,

A.R.S.M.

Minas de Riotinto,
Huelva, Spain, July 25, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 9, May 5, 1884.

Hydrate Formed by the Combined Carbon in Cast-iron.—M. Zaboudsky.—A re-publication from the *Comptes Rendus*.

Probable Number of Homologous and Isomeric Rosanilines.—MM. Rosenstiehl and Gerber.—In a former paper the authors have shown among the isomeric or homologous amines fit for the production of rosanilines there may be distinguished three classes. The number

of rosanilines is reduced to 24 arranged in 9 groups, or to 64 arranged in 13 groups.

A New Method of Determining the Carbon in Cast-iron, Steel, and Wrought-iron.—M. Zaboudsky.—For decomposing the specimen the author makes use of a dry mixture of copper chloride and sodium chloride prepared by evaporating the mixed solutions to dryness. The metal finely pulverised is carefully incorporated with this mixture in a mortar; water is added so as to form a pasty mass, and the whole is ground up with the pestle. It is well to place the mortar previously in cold water. For 1 grm. of iron 20 grms. of the mixture suffice. The trituration is kept up for half an hour. The mass is taken from the mortar and placed in a beaker. The mortar is rinsed with 200 c.c. of ferric chloride of mean concentration (1 part Fe_2Cl_6 to 4 parts of water). The beaker may be gently heated without adding hydrochloric acid. This entire operation takes scarcely 45 minutes when the residue may be collected on the filter. The author has determined the quantities of carbon contained in the residue submitted to combustion, and gives the results in a table. He considers that the calorimetric method of Eggertz may serve to determine the carbon rapidly, but it requires great skill, and the results are not mutually comparable with metals of different origin.

On Phosphorus Sulphides.—E. Dervin.—The author has examined the action of light upon a mixture of sulphur and phosphorus sesqui-sulphide dissolved in carbon disulphide; the action of heat upon a mixture of sulphur and phosphorus in solution in carbon disulphide; the action of heat upon mixtures of phosphorus sesqui-sulphide with phosphorus ter-sulphide or penta-sulphide in presence of carbon disulphide, and he has attempted to crystallise PS_3 and PS_5 as obtained by fusing red phosphorus and sulphur, by means of carbon disulphide under pressure.

Sodium Sulphites and Bisulphites.—R. De Forcrand.—The author has determined the formation-heat of these compounds.

Sodium Glyoxal-Bisulphite.—M. De Forcrand.—A thermo-chemical study.

Non-Existence of Ammonium Hydrate. — D. Tommasi.—This paper has been already noticed.

Action of Isobutyl Chloride upon Benzol mixed with Aluminium Chloride.—E. Gossin.—The reaction of MM. Friedel and Crafts with isobutyl-chloride differs from that with propyl- and amyl-chloride.

Reply to MM. Vincent and Delachanal.—F. Sestini.—The author's researches on the preparation of the sulpho-carbonates date back to 1871.

The Synthesis of Diphenylethane derived from Ethylidene Chloride.—R. D. Silva.—The author points out that he has obtained this result as early as 1881, and consequently prior to MM. Angelbis and Anschütz.

The Manufacture of Cyanides and Ferrocyanides by Means of Trimethylamine, according to Ortlieb and Muller's Process.—E. Willm.—Commercial trimethylamine converted into vapour in small boilers fed continuously is decomposed in retorts arranged like gas-retorts and heated to bright redness. It is decomposed into hydrocyanic acid, ammonium hydrocyanate, and carburetted gases. The vapours pass first into dilute sulphuric acid where the ammonia is retained, and thence into a lye of caustic alkali. To obtain ferrocyanides a determined quantity of pure ferrous oxide is added to the alkaline lye.

The Existence of Manganese in Wines.—E. J. Maumené.—Already noticed.

Zeitschrift für Analytische Chemie.
Vol. xxiii., Part 1, 1884.

The Determination of Phenol in Creosote Oil.—Dr. Kleinert.—All distillations give between 150° and 200° the smallest quantity of distillate; such creosote oils, therefore, contain extremely little phenol. It cannot be assumed that carbolic acid exists in those portions of the liquid which pass over at temperatures exceeding 200° as its boiling-point is at 184° to 185°. At most there might occur under the existing circumstances a quite unimportant minimum. Yet the fractions which distil over between 200° and 250° are not merely the most abundant, but they exhibit relatively the highest proportion of *supposed* phenol. The acid oils contain also bodies with boiling-points above 250°, and which behave with bromine similarly to phenol. If, therefore, the supposed phenol is determined in a creosote oil according to the method of Koppeschaar, the larger percentage consists not of phenol but of other bodies contained in the acid oils, soluble in water and having a higher boiling-point than that of phenol.

Remarks on the Applicability of Schlösing's Method of Determining Ammonia to the Extracts of Plants.—E. Schulze.—E. Bosshard, in a memoir contained in the Chemical News (vol. xxii., p. 329), has shown that in presence of glutamine neither Schlösing's method nor distillation with magnesia gives useful results and that the presence of asparagine also interferes with both these methods. The fact that asparagine does not absolutely resist the action of cold milk of lime causes Schlösing's method to appear erroneous in principle. But in the cold the decomposition of this amide by milk of lime proceeds very slowly and does not appear to begin immediately after these substances have been brought into contact. If in an extract containing asparagine the ammonia is determined according to Schlösing's method, and the acid is titrated back after forty-eight hours, the error will be slight even in presence of a considerable quantity of asparagine. The application of the method, however, has its disadvantages. The tests given in the text-books do not show whether, at the end of the experiment, all the ammonia originally present has been expelled. In the examination of amidiferous vegetable matter it will often be doubtful whether asparagine, or glutamine, or a mixture of both these amides, is present.

Determination of Organic Matter in Potable Waters, according to the Methods based upon the Reduction of Potassium Permanganate.—Dr. A. R. Leeds.—Already inserted.

The Separation and Quantitative Determination of Digitaline, Digitaleine, and Digitine.—R. Palm.—After critising the method of Nativelle and the so-called German process the author proposes to exhaust the plant with water, to filter off animal charcoal until entirely decolorised, and to precipitate the filtrate completely with lead acetate. The filtrate is then treated with solution of basic lead acetate and alcoholic ammonia as long as a precipitate is produced. This last precipitate consists of lead oxide and the glucosides of digitalis. It is washed on the filter, mixed up with water to a thin paste, and completely decomposed by treatment with hydrogen sulphide. The entire mass is then placed upon a filter. The watery liquid contains all the digitaleine whilst digitaline and digitine remain undissolved in admixture with the lead sulphide. If this residue is treated with chloroform the digitaline is dissolved and can be obtained in crystals on evaporating the solvent. The residual lead sulphide is treated with alcohol which dissolves the digitine. This substance remains behind in a state of purity on the escape of the alcohol. The lead-precipitate of digitaline may be distinguished from those of picrotoxine and solanine as follows:—1. The precipitate of picrotoxine is more slimy, and on the addition of strong sulphuric acid becomes saffon yellow. 2. The precipitate of digitaline is gelatinous, and on treatment with sulphuric acid becomes flesh-coloured, or buff. The precipitate of solanine is granular, and on treatment with sulphuric acid turns to a deep buff. If a little sugar is then added to the mixture it takes after some time a violet colour, which ultimately becomes blue.

Conversion of the Hyposulphites into Sulphates by Means of Potassium Permanganate.—G. Brügelmann.—A solution of permanganate, saturated in the cold, is added to the boiling solution of the substance until it has a distinct violet colour. The excess of permanganate is destroyed with alcohol, the precipitate of manganese is filtered off and washed, and the liquid obtained, after the expulsion of the alcohol if necessary, contains the sulphates in solution.

Contributions to Azotimetry.—Carl Mohr.—Already noticed.

Determination of Tartaric Acid in Wines.—R. Kayser.—All the methods in use have the defect of ignoring the tartaric acid which separates out as a neutral calcium salt. A case is given where the error amounted to 0·059 out of a total of 0·022 to 0·120.

Spectroscopic Valuation of Different Kinds of Pure Indigotine.—C. H. Wolff.—Already noticed.

The Hygrometer in the Exsiccator.—Dr. E. Fleischer.—By placing a Lambrecht hygrometer in his exsiccator the author has established that calcium chloride is of questionable value as an absorbent of moisture, and very far inferior to sulphuric acid. It is applicable when gases which are to be dried pass over it in a current (though even in this case a further proportion of moisture may be taken up by sulphuric acid, but in a stagnant stratum of air, as in the exsiccator it is of comparatively little value). By special experiments the author proves that sulphuric acid desiccates four times more rapidly than does calcium chloride.

Lilienfeld's Lamp for Petroleum which Boils at Low Temperatures.—Dr. F. Urech.—This paper cannot be intelligibly reproduced without the five accompanying illustrations.

Spirit-Lamp with a Constant Level.—C. Reinhardt.—This paper also requires the two accompanying illustrations.

Numbering Porcelain Crucibles.—C. Reinhardt.—The author proposes to mark the crucibles with enamel colours as prepared for painting on porcelain. A little of the finely ground colour is ground up in an agate mortar to a thick paste with oil of lavender or aniseed. It is applied to the crucibles with a very fine camel's hair pencil, not too thickly. The crucibles are set on an iron plate, which is gradually heated. When the colour is dry the crucibles are transferred to a muffle and the colour is burnt in.

Determination of Nitrogen.—Dr. Rube.—The author has made at least 3000 determinations of nitrogen, in manures, especially guano, by Ruffle's method. He has always obtained good comparable results by following strictly Ruffle's instructions. He employs always iron tubes, and after use lays them in water. Water is then pumped through them until they are quite clean. A tube serves for many combustions. When other analysts fail to obtain good results with Ruffle's method Rube has occasionally been able to ascertain that they have not followed Ruffle's directions. The determination of nitrogen by Kjeldahl's method is also successful, but it does not economise time.

Analyses of Pure Natural Wines.—R. Fresenius and E. Borgmann.—The results of the authors are given in a series of tables.

The Observation of the Ultra-red Portion of the Spectrum.—H. Becquerel.—From the *Comptes Rendus*.

Solubility of Glass in Various Reagents.—R. Cowper.—From the *Journal of the Chemical Society*.

Determination of the Specific Gravity of Minerals.—P. Gisovius.—The author makes use of a volumenometer based on the principle of Phipson and Brügelmann. As a solution he uses cadmium borotungstate.

Determination of Specific Gravity.—W. W. Nicol.—From the CHEMICAL NEWS.

A Modified Condenser.—W. A. Shenstone.—From the *Journal of the Chemical Society*.

Apparatus for Gas Analysis.—A. A. Breneman.—From the CHEMICAL NEWS.

A Modification of Bunte's Gas Burette.—H. von Jüptner.—This paper requires the accompanying illustration.

A New Form of Gasometer.—L. G. de Saint Martin.—From the *Bulletin de la Société Chimique de Paris*.

A Mercurial Cell as a Substitute for Caoutchouc Connections.—H. Michaelis.—Two forms of this device are figured in the original.

The Acceleration of Evaporation in Capsules.—H. Vogel.—The arrangement cannot be understood without the illustration.

Coating for Retorts.—E. Schaal.—Instead of the common mixture of asbestos and clay the author recommends a soft, moderately thin paste of infusorial earth and soluble sodium silicate; one part of the former being mixed with 4 to 4½ of the latter. It is applied so as to form a coating of ½ to 1 centimetre in thickness, and allowed to dry slowly.

The Preparation of Carbonic Acid Perfectly Free from Common Air.—S. Hoogewerff and W. A. van Dorp.—The authors grind up chalk, wash it, and dry it in the air. On adding sulphuric acid of full strength pure carbonic anhydride is given off.

Volumetric Determination.—A. Belohoubek had formerly proposed to reduce the acid solution of uranic salts with zinc and to titrate the uranous oxide thus formed with permanganate. According to his experiments the process is equally practicable in sulphuric and in hydrochloric solutions. Follenius subsequently proved that if much hydrochloric acid is present the result is too high on account of the liberation of chlorine. Clemens Zimmermann found that the uranic salts in a sulphuric solution are reduced by zinc to uranous salts and can be very accurately determined by means of permanganate. The determination in hydrochloric solutions is practically only when the air is excluded during titration, and the disturbing influence of the hydrochloric acid is obviated by an addition of manganous sulphate. He operates as follows:—The uranium compound is heated with hydrochloric acid and zinc in a small flask fitted with a Bunsen valve. The yellow colour of the solution passes into green, dirty green, dirty brown, and finally into a splendid red. The reduction is then complete. A quantity of permanganate, more than is required, is poured into a capsule, strongly acidified with sulphuric acid, manganous sulphate is added, and the hot reduced solution is poured rapidly into this mixture. The excess of permanganate is removed by means of a standard solution of ferrous sulphate, and the liquid is finally titrated with permanganate. The same author bases a volumetric process for the determination of uranium compounds upon the following reactions:—If a uranous solution is mixed with an acidified solution of potassium dichromate the uranous salt is rapidly oxidised, whilst iodine is liberated from potassium iodide and determined by means of a solution of sodium hyposulphite. The solution to be titrated is placed in a porcelain capsule, acidified with hydrochloric acid, mixed with an excess of a dichromate solution of known strength, diluted with water to about 150 c.c., and an aqueous solution of potassium iodide is added, stirring constantly. The liberated iodine is determined by means of a standard solution of hyposulphite of known strength in presence of starch paste, and very dilute iodine solution of known strength is added until the blue iodide of starch is formed.

Separation of Nickel from Cobalt.—G. Delraux and G. Vortmann.—Already inserted.

The Occurrence of Pyridine in Commercial Ammonia.—H. Ost.—From the *Journal fur Praktische Chemie*.

THE CHEMICAL NEWS.

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A REMINISCENCE OF DR. DALTON.*

By CHARLES CLAY, M.D.

I THINK, but am not quite certain, that it was in the year 1816 or 1817 I was an apprentice to Kinder Wood, Surgeon, 51, King Street, Manchester. About that time the Marsden School of Medicine began its operations, of which my master had the Midwifery Class jointly with Mr. Partington. Jordan and Bluntstone on Anatomy, Dalton on Chemistry, Fawdington on Surgery, Davies on Botany, and some others. I mention this as it has often been stated that the Pine Street School of Medicine was the first in Manchester, *which is not correct.*

Among other lectures I was advised by my master to attend the Lectures on Chemistry, by Dalton, which I did. The course consisted of ten lectures, which were to be extended afterwards. I thus became a pupil to Dalton. At that time he was busy experimenting on gases, and he asked my master if he could suggest any plan by which he could obtain some of the gases of the coal-pits, more especially what was usually called fire-damp. Mr. Wood replied, he had a friend in Oldham whose pits were unusually troubled with fire-damp and had had many serious explosions; and if Dr. Dalton was very anxious he would try, *but how*? The Dr. then suggested some bottles filled with water, then taken into the mine and emptied, and when emptied well corked. Mr. Wood said he thought he would send his apprentice to his friend with bottles and instructions, and he felt sure it would be attended to correctly. *I was then asked, and willingly volunteered to go.*

Four wine bottles, which the Dr. thought sufficient, were got, and a wine basket that just held them, with a piece of sealing-wax in my pocket and four tightly-fitting corks greased at the ends, to be inserted. I started for Oldham with the note. Mr. Wood drove me as far as Hollinwood; from thence I walked to Oldham, and with some difficulty found the gentleman, who was just starting on a journey. After reading the note he smiled, and asked me to get into his gig. He drove right to the pits, explained the matter fully to his manager, and left me in his care. The underlooker was then signalled from the pit, and soon after made his appearance, black enough from head to foot. Careful instructions were given to him on taking the basket. I interfered, and said I had come to see the matter myself, and therefore wished to go into the pit. The manager smiled, and asked me if I had ever been in a coal-pit; I said no, but I was ready to go. So in the end we prepared to start; I was placed in the tub with the underlooker, who went with me one leg in the tub and the other outside, to guard the descent, as there were no conducting-rods. On progressing downwards I felt a curious sensation as though I should be sick, and I sensibly felt I was descending rapidly on looking at the sides of the pit; but when the light failed the motion appeared reversed, as though I was going upwards. In a few seconds more I felt the elasticity of the rope, which felt as though it elongated and contracted alternately, and which produced something like sea-sickness: on the tub reaching the floor of the mine I got out, and was surrounded by about half a dozen black-faced mortals, full of curiosity as to what I could want there. What had the bottles in them? Was it gin? My conductor replied, "*Nobbut water*"; loud laughter followed. "Neaw, lads," says the conductor, "look handy; two of you go with me and this lad as far as we can with candles, and then stop for orders."

The conductor took the basket preceded by one of the men. I followed, and a man followed me; in this order we marched along the mine. I felt the iron rails beneath my feet. After proceeding for a considerable distance I heard a noise like thunder, and enquired what it was. The conductor said only the waggons. "Now," said he, "stand close to the wall." I had no sooner done so when four waggons of coal were pushed past by lads. We then proceeded as before; at last we got to a point that the conductor called out *Halt*, and put out all candles but one that was put into a lump of clay and fastened on the wall of the passage.

"Now go on carefully." Soon after we came to a turn and entered another drift, where we had to creep in a bent position. My breathing at this time became difficult, I felt great oppression about my chest, and the perspiration was profuse all over my body. The conductor called out to me, "Heaw dost feel, lad?" I said, "Not very well!" "Con theaw manage a bit further?" I replied, "I think I can." We then proceeded, but in a short time we stopped. The conductor declared it was not safe to go further. "Neaw, lad," said he, "get done what theaw has to do." He gave me the basket; I felt for the bottles, took one and gave a cork to one of the party, and having emptied the water out gave the bottle to be corked well, instructing him to force it in well, and so on with the other three bottles, which when finished I said I was ready to return, the bottles being put mouths downwards into the basket.

We then began to retrace our steps, and every few seconds I felt a sensible relief in my breathing. Turning from the narrow drift into the main track, we progressed more rapidly, until I could see a glimmer of light at a distance. It was the candle we had left, and by the time we arrived at it I felt no difficulty at all in my breathing. I now asked the men to stay a few minutes. One held the candle, and I took the piece of sealing-wax out of my pocket, melted it at the candle,—having first cut the cork off level,— smeared it over with the wax. We then proceeded, and soon arrived at the bottom of the shaft. Five or six miners, now full of curiosity, crowded round. One said "That's a queer go, bringing water and taking nowt back." "Aye," said another, "and corking *nowt* down, as if it would jump out." These remarks were cut short by my conductor telling me to get into the tub, basket and all. The signal given we mounted, and left our curiosity mongers no wiser.

The same sensations accompanied me up as on the way down, and when we emerged from the pit's mouth the sun was shining brilliantly, and the more so it appeared from being in the dark regions for some hour and a half; the daylight was to me a pleasurable surprise and delight. I experienced a similar sight in after years on emerging from the Peak Cavern in Derbyshire, after a long visit in its interior, on rounding the angle of a rock and coming suddenly to where the light came streaming in. But to my narrative: the underlooker gave an account to the banksman, who remarked that I should make a collier in time; then sent a lad with me to carry the basket and show me the way to Manchester Street, in Oldham. Having arrived there, I looked about me to see if there was any way of riding to Manchester; seeing none, I trudged along homewards. After I had gone a mile or so I saw a stand coach, with the horse's head towards Manchester, standing at a public-house door. I went in and asked the driver if he would give me a lift to Manchester. He asked me in return "If I saw any green in his eye?" After he had perpetrated his joke he told me he would take me for five shillings. I said I had no five shillings to spend, but if he would take me and the basket to 51, King St., Manchester, I would give him half a crown. After some demur he said "Well, get in"; and off we set, and a weary ride I got. He stopped at almost every

* A Paper read before the Manchester Literary and Philosophical Society, April 15, 1884.

public-house either to drink or let his horse drink. In two hours I landed safely in King Street. Mr. Wood was delighted and laughed heartily at my account, paid the man his two shillings and sixpence, and sent me to wash and refresh myself. When that was done I was sent to George Street with my bottles. The Doctor received me very kindly, and the quiet twinkle of his eye showed his satisfaction, which was greatly increased when he learned the particulars of my travels. He eyed the bottles with great satisfaction; he looked at the corks closely sealed, and seemed puzzled. I asked him what he was going to do with them? "Well," he said, "I am thinking how I am to get the corks out without mixing it, more or less, with the atmosphere. I want to put the air into that receiver on the shelf of that pneumatic trough." I said, "I think I could do it." He looked at me and said, "How?" I said, "File the bottle-neck round, and then a smart tap under the water I think will do it." He said "Capital, thou shalt try." He gave me some coppers to fetch a file, and I soon filed a bottle-neck round, then held it under the shelf of the pneumatic trough, a gentle tap with the handle of a knife, and the air-bubbles very speedily rose into the receiver. The other bottles were beheaded, and very soon I took leave of the Doctor, who was apparently well pleased, and on parting said, if there was anything in his lectures which I did not understand, he wished me not to hesitate, but ask him, and he would always willingly assist me, and he was as good as his word; in fact, he showed me many little kindnesses afterwards, and so ends my small reminiscence of Dr. Dalton.

DETECTION AND DETERMINATION OF PICRIC ACID.

By G. CHRISTEL.

This compound forms yellowish white leaflets which take up ammonia on exposure to the air and assume a deep yellow colour. The solutions of tri-nitrophenol in dilute acids, in chloroform, and carbon disulphide are colourless. If the solution in chloroform is evaporated to dryness there remains a colourless residue which is coloured deep yellow by a drop of water. If a yellow (ammoniacal) picric acid is dissolved in a little water, mixed with two or three volumes of ether, and shaken up, a part only of the acid is taken up by the ether, and further additions of ether dissolve scarcely any colouring matter. The addition of acetic acid does not alter this behaviour, but after adding a little sulphuric acid the entire picric acid may be extracted with ether. Ammonia withdraws the dissolved picric acid from ether; and the golden-yellow ammonium picrate is insoluble in ether. Chloroform removes only a part of picric acid from its pure watery solution or from one which has been acidulated with sulphuric acid. In searching for picric acid it is therefore best to acidulate with sulphuric acid and exhaust by shaking up with ether.

If to a solution of picric acid or ammonium picrate in water we add neutral lead acetate or copper sulphate there is no precipitate, but on further adding a little alkali (ammonia) there is formed with lead acetate a reddish yellow precipitate, and with copper sulphate a greenish precipitate. On the other hand, 1-20th milligrm. picric acid dissolved in 5 c.c. water with a few drops of basic lead acetate becomes strongly opalescent, and gives subsequently a slight but distinct yellow precipitate. This precipitate is decomposed by dilute sulphuric acid. If the same precipitate is submitted to prolonged treatment with water, a part of the picric acid is dissolved, whilst there remains an apparently more basic compound of a deep orange-yellow.

The yellow colouring-matters of *Quercus tinctoria* (quercitron bark) and of *Broussonetia tinctoria* (fustic) behave in a similar manner with the salts of lead. These and analogous colouring matters are distinguished from picric acid thus: they are neither changed by potassium cyanide nor reduced by potassium stannite. Their precipitates are never so pale yellow as that of picric acid. The soluble aniline yellow of commerce dissolves to a reddish yellow liquid, which if much diluted appears of a pure yellow. It is very imperfectly precipitated by basic lead acetate, not changed by potassium cyanide, but turned at once to a purple by hydrochloric acid.

If a solution of tri-nitrophenol, not too dilute, is mixed with an aqueous solution of methyl green, there appears a green precipitate which in excess of water dissolves to a bluish green liquid. It is soluble also in acetic acid and in other acids. With organic bases (alkaloids) picric acid gives precipitates, as is well known, but they are not suitable for its separation. On boiling solutions of picric acid with permanganate considerable quantities of the latter are reduced. If to an aqueous solution of picric acid there is added stannous chloride, a yellowish brown precipitate falls down, but if a little ammonia is added, or if potassium stannite is used, the liquid becomes red from the formation of picramic acid. If to a solution of barium chloride there are added a few crystals of caustic baryta and a solution of picric acid, not too dilute, there is formed a red precipitate. Sulphuretted hydrogen reddens an alcoholic solution of picric acid. The same effect is rapidly produced by ammonium sulphide. By the action of zinc and dilute sulphuric acid upon picric acid there is formed a yellowish red turbid liquid. If this is decanted off from the zinc, mixed with an excess of alcohol (ethylic), allowed to stand for some time and filtered, the liquid becomes greenish, and changes first to a violet-blue and then to a reddish violet. If even a very small quantity of picric acid (much less than 1 milligrm.) or of an alkaline picrate is heated with hydrochloric acid and stannous chloride, allowed to cool, a trace of potassium chlorate added to the mixture slightly heated, the liquid becomes first greenish yellow and then a fine blue, but an exceedingly trifling excess of potassium chlorate destroys the colour. In presence of organic matter this reaction is not distinct. One of the most sensitive and trustworthy reactions is the well-known transformation of picric acid into red phenyl-purpuric acid on heating with potassium cyanide. Tri-nitrocresol, in like manner, forms cresyl-purpuric acid on treatment with potassium cyanide. If an aqueous solution of picric acid, not quite saturated, is mixed with potassium sulphocyanide and the mixture heated, there appear in the liquid (which at first remained clear) numerous yellow crystalline needles, which reflect incident light with splendid green and red colours. If the crystals are separated from the liquid, dried, and touched with an incandescent body they explode with extreme violence. Nitrogenous tissues (wool, silk) take a permanent yellow in an aqueous solution of picric acid; absolute alcohol, hydrochloric acid, dilute caustic alkalies, and aqueous ammonia withdraw the picric acid, partially or entirely, from such tissues. The residue from the evaporation of the ammoniacal solution thus obtained is particularly fitted for the basic acetate of lead reaction and for that with potassium cyanide. Animal charcoal, if added in small quantities to a solution of picric acid, does not decolourise it, but larger quantities entirely withdraw picric acid from its solutions

To detect picric acid in beer Christel evaporates 200 c.c. to the consistence of a syrup; introduces the residue into a small flask, adds 50 c.c. of alcohol at 90 per cent, lets it stand for twenty-four hours, during which the whole is repeatedly well shaken up, filters, extracts again with 30 c.c. alcohol, evaporates the mixed filtrates to the consistence of a syrup, adds to the residue 4 to 5 drops of dilute sulphuric acid (1 : 3), and then mixes it with 5 to 6 volumes of ether in a test-tube closed with a cork. After the mixture has undergone strong and prolonged shaking the ether is decanted, 2 or 3 drops of sulphuric acid are added to the residue, which is again shaken out with ether. The mixed ethereal solutions are evaporated in a porcelain capsule

at common temperatures, the residue is diluted with water to 5 to 10 c.c., filtered, and neutralised with ammonia. The solution thus obtained can be further tested as above. Christel determines picric acid colorimetrically, comparing the intensity of the colour of a solution of phenyl-purpuric acid obtained from the substance under examination with the intensity of solutions prepared simultaneously and under the same conditions from different but known quantities of picric acid. This procedure admits of determinations as close as 1 milligrm. picric acid in 100 c.c.—*Zeitschrift f. Analytische Chemie and Archiv. der Pharmacie.*

ON THE

FORMATION OF DIBENZYL BY THE ACTION OF ETHYLENE CHLORIDE ON BENZOL IN THE PRESENCE OF ALUMINIUM CHLORIDE.*

By WILLIAM H. GREENE.

By a series of the most remarkable chemical investigations of late years MM. Friedel and Crafts have shown that the radicles of the saturated hydrocarbons can be grafted upon the benzol nucleus by the action of aluminium chloride upon a mixture of benzol and the monatomic chlorides, bromides, &c. Thus, on passing methyl chloride into benzol in which aluminium chloride is suspended, all of the methyl derivatives of benzol, from toluol to hexa-methyl benzol, may be formed, according to the proportions of benzol and methyl chloride which are brought into contact. In the same manner the ethyl, propyl, and other derivatives of benzol may be obtained abundantly.

In these reactions hydrochloric acid is disengaged, and the explanation proposed by Friedel and Crafts supposes the reaction to take place in two phases:—In the first a compound of benzol and aluminium chloride is formed, with elimination of hydrochloric acid:—

$$C_6H_6 + Al_2Cl_6 = C_6H_5.Al_2Cl_5 + HCl.$$

In the second the aluminium-benzol compound reacts upon the monatomic chloride present, the organic radicle entering the benzol nucleus, and aluminium chloride being re formed:—

$$C_6H_5.Al_2Cl_5 + CH_3Cl = C_6H_5.CH_3 + Al_2Cl_6.$$

A small quantity of aluminium chloride serves for the preparation of an indefinite quantity of the new hydrocarbon,

By the action of aluminium chloride on the monatomic chlorides alone, hydrochloric acid is also eliminated, and the radicle is condensed. Hence the reaction which would take place between benzol and a polyatomic chloride under the same circumstances cannot be entirely foreseen. It seems possible that in the case of ethylene chloride, for example, both atoms of chlorine might be replaced by phenyl groups; but it would seem more probable that, after the first substitution, one molecule of hydrochloric acid would be removed from the ethylene chloride, and that a more condensed hydrocarbon, styrol, would be formed. However, the first reaction is that which actually occurs.

When aluminium chloride is introduced into a mixture of benzol and ethylene chloride the reaction begins in the cold, and becomes energetic on the application of heat. Hydrochloric acid is disengaged abundantly: when the reaction has ceased the mixture is thrown into water to separate the aluminium chloride, and the oily liquor which separates is heated with alcoholic potassium hydrate, in order to decompose any remaining ethylene chloride.

After washing and drying the product it yields, on fractional distillation, very nearly the theoretical quantity of dibenzyl; after which a thick oily mixture remains, which does not completely distil at 200° in a vacuum. This mixture consists of condensation products, and yields no satisfactory results, as it cannot well be fractionated, and does not solidify in a freezing mixture.

Pure dibenzyl melts at 52·5° to 53°, and boils at 279°, under a pressure of 767 millimetres, the thermometer being entirely immersed in the vapour. This boiling-point is lower than that given by Cannizaro and Rossi (284°), and higher than that indicated by Fittig (272°).

* Read before the American Philosophical Society.

ON THE

ACTION OF HYDROCHLORIC ACID AND OF CHLORINE ON ACETO-BENZOIC ANHYDRIDE.

By WILLIAM H. GREENE.

In a note published in the *Bulletin de la Société Chimique* (32, 164), M. Loir states that aceto-benzoic anhydride prepared by the action of benzoyl chloride on sodium acetate is decomposed by hydrochloric acid at 130°, into acetyl chloride and benzoic acid, while at 140° chlorine converts it into acetyl-chloride and chloro-benzoic acid; under the same circumstances the anhydride made by the reaction of acetyl-chloride with sodium benzoate yields nothing, but at 160° hydrochloric acid converts it into bezoyl chloride and acetic acid—with chlorine at 170° it yields benzoyl chloride and chlor-acetic acid.

These reactions appeared extremely improbable. Aceto-benzoic anhydride begins to decompose at a temperature below 150° into acetic anhydride and benzoic anhydride; at temperatures near this point it should act with reagents as would a mixture of the two anhydrides. Besides this, M. Loir determined the nature of his decomposition products by putting them in water, and did not, it appears, attempt to fractionate his distillates in any manner. Acetic anhydride is decomposed by hydrochloric acid at ordinary temperatures, and aceto-benzoic anhydride, a less stable compound, would hardly withstand the action of the same reagent at temperatures near 100°.

I have repeated the experiments of M. Loir with the following results:—

If dry hydrochloric acid be passed into aceto-benzoic anhydride at ordinary temperatures, the reaction is the same, by whichever process the anhydride may have been prepared; benzoic acid is deposited, and the tube conveying the hydrochloric acid becomes obstructed. On raising the temperature, acetyl-chloride begins to distil at 55° to 60°, and the product obtained up to 130° is a mixture of acetyl-chloride and acetic acid. If the heat be raised much above 130°, and the current of hydrochloric acid rapid, a small quantity of benzoyl-chloride is carried over and will be found in the distillate. The residue in the apparatus consists of benzoyl-chloride and benzoic acid. If the anhydride be heated to 130°, or any other temperature, before passing the hydrochloric acid, the reaction is the same with the anhydride prepared by each process. However, it seems that the lower the temperature the greater the proportions of acetyl-chloride and benzoic acid which are formed, while at higher temperatures (130 to 150°) the reaction yields acetyl-chloride, acetic acid, benzoyl-chloride, and benzoic acid in about equivalent proportions.

Chlorine acts in an analogous manner; the products are the same in whichever manner the anhydride may have been prepared; but with the exception of the acetyl-chloride, these products are more difficult to separate than those formed in the reaction with hydrochloric acid. Indeed, chloracetic acid boils at about 186°, and benzoyl-chloride at 198°; yet, in the experiments of M. Loir, the latter compound seems to have distilled over first, leaving the chloracetic acid in the retort. At temperatures near 150° the products of this reaction are acetyl-chloride, chloracetic acid, benzoyl-chloride, and o-chloro-benzoic

acid; at lower temperatures the principal products are acetyl-chloride and chloro-benzoic acid.

From his experiments M. Loir concludes that the constitution of benzoyl acetate differs from that of acetyl-benzoate; but the results of these experiments being erroneous, such a conclusion is unsustained. The bodies thus named are identical, all of their reactions *under the same conditions* are the same, and they must be represented by the same rational formula.—*American Chemical Journal.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

OSMIUM.

THE atomic weight of this metal has been determined by Berzelius and by Fremy.

Berzelius† analysed potassium osmichloride, igniting it in hydrogen like the corresponding platinum salt. 1·3165 grms. lost 0·3805 of chlorine, and the residue consisted of 0·401 grm. of potassium chloride, with 0·535 grm. of osmium. Calculating only from the ratio between the Os and the KCl, we have, Os = 198·494; or, if O = 16, Os = 198·951.

Fremy's determination,‡ is based upon the composition of osmium tetroxide. No details as to weighings or methods are given; barely the final result is stated. This, if O = 15·9633, is Os = 199·190. If O = 16, Os = 199·648.

Berzelius's work is evidently entitled to preference, although neither determination is in any sense equal to the present requirements of chemical science. The values given are doubtless several units too high.

IRIDIUM.

The only early determination of the atomic weight of iridium was made by Berzelius,‖ who analysed potassium iridichloride by the same method employed with the platinum and the osmium salts. The result found from a single analysis was not far from Ir = 196·7. This is now known to be too high. I have not, therefore, thought it worth while to recalculate Berzelius's figures, but give his estimation as it is stated in Roscoe and Schorlemmer's "Treatise on Chemistry."

In 1878 the matter was taken up by Seubert,§ who had at his disposal 150 grms. of pure iridium. From this he prepared the iridichlorides of ammonium and potassium, $(NH_4)_2IrCl_6$ and K_2IrCl_6, which salts were made the basis of his determinations. The potassium salt was dried by gentle heating in a stream of dry chlorine.

Upon ignition of the ammonium salt in hydrogen, metallic iridium was left behind in white coherent laminæ. The percentages of metal found in seven estimations were as follows:—

43·742
43·725
43·745
43·739
43·726
43·739
43·705
Mean 43·732 ± 0·0035

The potassium salt was also analysed by decomposition in hydrogen with special precautions. In the residue the iridium and the potassium chloride were separated after the usual method, and both were estimated. Eight analyses gave the following results, expressed in percentages:—

Ir.	2KCl.	Cl_4.
39·881	30·829	29·290
39·890	30·842	29·277
39·868	30·813	29·300
39·876	30·835	29·289
39·877	30·825	29·287
39·879	30·811	29·310
39·882	30·814	29·285
39·883	30·792	29·288
Mean 39·880 ± 0·0015	30·820 ± 0·0037	29·291 ± 0·0024

From these data several values for the atomic weight of iridium may be calculated:—

From per cent Ir in $(NH_4)_2IrCl_6$ ..	Ir = 192·951	± 0·064
,, ,, K_2IrCl_6	,, 192·536	0·060
,, KCl in ,, ...	,, 192·474	0·111
,, Cl_4 in ,, ...	,, 192·757	0·148
General mean	,, 192·702	0·039

If O = 16, this becomes Ir = 193·145.

In the potassium salt, instead of calculating from the percentages directly, we may reckon upon the ratios between Ir and Cl_4, and between Ir and 2KCl:—

From Ir : Cl_4 ratio..	Ir = 192·626	± 0·081
,, Ir : 2KCl ratio	,, 192·514	0·044
General mean	,, 192·539	0·039

Or, if O = 16, Ir = 192·982.

Again we may combine this mean with the value derived from the ammonium iridichloride, and so estimate the relative importance of the latter:—

From K_2IrCl_6	Ir = 192·539	± 0·039
,, $(NH_4)_2IrCl_6$	,, 192·951	0·064
General mean ..	,, 192·651	0·033

If O = 16, this becomes Ir = 193·094.

We may assume, then, from all the facts before us, that if O = 16, the atomic weight of iridium varies from the even number 193 only within the limits of experimental error.

PALLADIUM.

The atomic weight of palladium has been studied by Berzelius and by Quintus Icilius. In an early paper Berzelius* found that 100 parts of the metal united with 28·15 of sulphur. Hence Pd = 113·63, a result which is unquestionably far too high.

In a later paper† Berzelius published two analyses of potassium palladiochloride, K_2PdCl_4. The salt was decomposed by ignition in hydrogen, as was the case with the double chlorides of potassium with platinum, osmium, and iridium. Reducing his results to percentages, we get the following composition for the substance in question:—

Pd.	2KCl.	Cl_2.
32·726	46·044	21·229
32·655	45·741	21·604
Mean 32·690	45·892	21·416

From these percentages, calculating directly, very discordant results are obtained:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Poggend. Annal.*, 13, 539. 1828.
‡ *Comptes Rendus*, 19, 485. *Journ. f. Prakt. Chem.*, 53, 410. 1884.
‖ *Poggend. Annal.*, 13, 425. 1828.
§ *Ber. der Deutsch. Chem. Gesell.*, 11 1767.

* *Poggend. Annal.*, 8, 177. 1826.
† *Ibid.*, 13, 454. 1828.

From percentage of metal	Pd =	106·612
,, ,, KCl	,,	104·674
,, ,, Cl_2 (loss) ..	,,	110·796

Obviously, the only way to get satisfactory figures is to calculate from the ratio between the Pd and 2KCl. Doing this, we get, Pd = 105·737; or, if O = 16, Pd = 105·981.

This last value varies so slightly from the even number 106 that the latter may be safely used for all purposes of chemical calculation.

The determination made by Quintus Icilius* need be given only for the sake of completeness. He ignited potassium palladiochloride in hydrogen, and found the following amounts of residue. His weights are here recalculated into percentages :—

64·708
64·965
64·781

Mean 64·818

From this mean, Pd = 111·879. Upon looking at the values deduced from Berzelius's figures, it will be seen that the highest, 110·795, is calculated from the chlorine lost upon igniting the palladiochloride. The same kind of error which vitiates that result probably affects also these data drawn from the palladiochloride.

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.

By C. LORING JACKSON and A. E. MENKE.

(Continued from vol. xlviii., p. 100.)

OWING to the difficulty of preparing curcumin, and the very unmanageable nature of the products obtained from it and from turmerol, we have not made as much progress in the study of these substances as we had hoped. In fact, we should not publish our results at the present time were it not that we cannot continue the work together at all, and neither of us will be able to return to it for at least a year; we have therefore decided to collect in the following papers all the results we have obtained up to this time, although many of them are very fragmentary, and others consist only in indications which may prove useful in future work.

IV. CURCUMIN.

Action of Acetic Anhydride upon Curcumin.

Monacetcurcumin, $C_{14}H_{13}(C_2H_3O)O_4$.—This substance is formed by the action of acetic anhydride and fused sodic acetate on curcumin: probably also by the action of acetyl chloride. As has been stated in a previous paper,† it forms an uninviting brown resin, which we have not as yet succeeded in bringing into a crystalline condition; but, nevertheless, it can be obtained in a state of purity by the following method :—Curcumin is heated on the water-bath with a slight excess of acetic anhydride and a little fused sodic acetate for about sixteen hours in a flask with a return cooler; the dark brown viscous product is then dissolved in a little glacial acetic acid and precipitated with water. After repeating the solution in acetic acid, and precipitation with water, the yellowish brown precipitate is washed until free from acetic acid, and dried *in vacuo*.

0·1710 grm. of substance gave 0·4178 grm. of carbonic dioxide and 0·0922 grm. of water.

	Calc. for $C_{16}H_{16}O_6$.	Found.
Carbon	66·67	66·62
Hydrogen ..	5·55	5·99

Properties.—A viscous brown mass without definite melting-point, although it shrinks together at 58° to 60°, but it does not become fully liquid below 100°. It is soluble in alcohol and glacial acetic acid, essentially insoluble in ligroine and carbonic disulphide, slightly soluble in ether and in benzene; but its solubility in the latter is greater than that of curcumin. It dissolves in strong sulphuric acid with a blood-red colour like that produced by curcumin. Aqueous sodic hydrate dissolves it, forming a red solution, which becomes decomposed, with the formation of ill-defined black products, when allowed to stand exposed to the air. A mixture of alcohol and sodic carbonate was reddened instantly by the substance, showing that the acetyl group had replaced the hydrogen of the phenol hydroxyl, as was to be expected; that is, its formula would be—

$$C_6H_3(\overset{3}{O}CH_3)(O\overset{4}{C}_2H_3O)(C_6H_6\overset{1}{C}OOH).$$

As has been stated already,* the substance gave unsatisfactory results when submitted to oxidation with potassic permanganate.

Diacetcurcumin, $C_{14}H_{12}(C_2H_3O)_2O_4$.—On one occasion the process described above yielded a yellow crystalline product instead of the brown viscous monacetcurcumin. The coming of the vacation interrupted our work before we had succeeded in determining the conditions on which the formation of this substance depends, the few experiments which we had time to try giving invariably monacetcurcumin; we must, therefore, for the present, confine ourselves to describing the properties and analysis of the substance. After the removal of the acetic anhydride and sodic acetate by treatment with water, it was purified by washing with alcohol and crystallisation from glacial acetic acid, dried at 100°, and analysed.

0·2230 grm. of substance gave 0·5348 grm. of carbonic dioxide and 0·1090 grm. of water.

	Calc. for $C_{18}H_{18}O_6$.	Found.
Carbon	64·45	65·39
Hydrogen ..	5·45	5·43

Properties.—It crystallises from glacial acetic acid in rosettes of a vivid yellow colour without the orange shade of curcumin, which are made up of very characteristic rhombic plates; melting-point 154°. It is more soluble in glacial acetic acid than in any other solvent, especially when the acid is hot; less soluble in alcohol than curcumin; slightly soluble in ether and benzene; essentially insoluble in ligroine and carbonic disulphide. Strong sulphuric acid dissolves it, becoming blood-red in transmitted light, green like rosaniline in reflected light; the red colour is somewhat more purple than that produced by curcumin. Sodic hydrate in aqueous solution acts upon it very slowly, and not rapidly, even if dissolved in dilute alcohol. The red solution thus obtained gives with hydrochloric acid a viscous brown mass with a low melting-point, which seems to be impure monacetcurcumin. Sodic carbonate and alcohol give an orange solution looking like that of potassic dichromate. According to the formula given by us to curcumin in our first paper this substance should be a mixed anhydride of curcumin and acetic acid, with the other acetyl group attached to the phenol oxygen, as in the monacet compound—a constitution which would be expressed by the following formula :—

$$C_6H_3(OCH_3)(OC_2H_3O)(C_6H_6COOC_2H_3O).$$

That the carboxyl group is affected by the introduction of the second acetyl is shown by the fact that alkaline reagents act upon it only after some time, and then evidently decompose it; whereas the monacet compound is attacked by them instantly, and the action consists only in the formation of a salt; but, on the other hand, the substance is more stable than acid anhydrides are usually, as is shown

* Die Atomgewichte vom Pd, K, Cl, Ag, C, und H, nach der Methode der kleinsten Quadrate berechnet." Inaug. Diss. Gottingen, 1847. Contains no other original analyses.

† *American Chemical Journal*, iv., 19; and *Proc. Amer. Acad.*, xvii., 123.

* *Loc. cit.*

by this very action with alkalies, and by the fact that it can be boiled with water for many hours without undergoing any change in melting-point or the formation of any soluble acid.

Action of Phosphoric Oxychloride on Curcumin.

Of all the reactions of curcumin which we have observed this is by far the most striking, and we have decided therefore to describe it at some length, although we have not succeeded in determining the nature of the substance formed. If a few drops of phosphoric oxychloride are added to some curcumin suspended in ligroine, its orange-yellow colour is converted instantly into a rich reddish purple, which in reflected light appears bronze-green with a metallic lustre, between the colours of rosaniline and Hofmann's violet. To prepare the substance in quantity the curcumin was rubbed in a mortar with phosphoric oxychloride diluted with ligroine and afterward washed repeatedly with ligroine; the dark purple viscous mass thus obtained was dried in a desiccator over sulphuric acid, lime, and paraffin. This treatment, the best which we could devise, was usually far from effectual, as in every case but one the substance contained phosphorus, and was invariably converted during drying into a black mass having very different properties from the purple viscous substance at first obtained. The analysis of the substance free from phosphorus gave results less than one per cent higher than those required by curcumin, and this was confirmed by the analysis of one of the preparations containing phosphorus, after the phosphorus present had been calculated as phosphoric acid, and subtracted from the weight of the substance.

The properties of the purple product are quite as striking as its formation from curcumin, for the addition of water converts it again into curcumin, and the change from purple to orange-yellow is instantaneous. That curcumin was formed in this case was shown by the melting-point, 178°. Alcohol also changes the colour instantly from purple to yellow, but the product is much more soluble in alcohol than curcumin, and is possibly its ethyl-ether. Ether acts in the same way, leaving on evaporation a viscous red mass; in ligroine and benzene it is essentially insoluble. By standing even in a desiccator it is gradually decomposed—more rapidly at 100°—into a black mass, which is unaffected by water, but soluble in alcohol or sodic hydrate, forming dark solutions. Owing to the uninviting properties of this decomposition product it was not studied further.

It is highly probable that the blood-red colour imparted to strong sulphuric acid by curcumin is due to this substance, as curcumin is deposited when this solution is diluted. As to the nature of the purple substance our analyses show nothing; but its easy conversion into curcumin by the addition of water indicates that it is an anhydride, and we are inclined to believe that the carboxyl of the curcumin alone is involved in the reaction, because we obtained a similar but somewhat redder colour when monacetcurcumin was treated with phosphoric oxychloride.

In our first paper on curcumin we assigned to it the formula $C_6H_3(OH)(OCH_3)(C_6H_6COOH)$. Our work since then has been directed toward the determination of the structure of the side-chain C_6H_6COOH, and, although we have not succeeded in proving anything about it definitely, we may be allowed to state that our results can be explained by the assumptions that the carboxyl is attached to the carbon atom next but one to the benzene ring, and that in the remainder of the side-chain some of the carbon atoms are united to form a ring.

TURMEROL.

In our first paper on this subject we mentioned that, although turmerol is converted into terephthalic acid by treatment with an excess of a hot solution of potassic permanganate, the same reagent produces, when cold and not in excess, one or more apparently new acids. In the following paper we describe our study of the product of this reaction, a complex mixture of acids, from which we have succeeded in isolating two new acids—one having the formula $C_{11}H_{14}O_2$, which we propose to call turmeric acid; the other either $C_{10}H_{12}O_4$, or $C_{10}H_{10}O_4$, to which we would give the name apoturmeric acid.

In order to obtain this product a little turmerol was allowed to stand at ordinary temperatures with a moderately strong solution of potassic permanganate until the latter was reduced. The operation was carried on in large beakers, and the yield seemed to be better when not more than 500 c.c. of permanganate solution were used in each oxidation than when larger quantities were employed: with this amount the action came to an end in about three days. After the liquid had become colourless, the oxide of manganese and unaltered oil were removed by filtration and again treated with permanganate solution; this treatment being repeated until the permanganate ceased to act, when it was found that the oxide of manganese was essentially free from organic matter, and therefore that the entire product was contained in the aqueous filtrate. The mixed filtrates from a number of operations were then concentrated on the water-bath, acidified with sulphuric acid, extracted several times with ether, and the extract, a black tarry liquid, distilled with steam, when a yellow oil (A) passed over with some difficulty; this was mostly turmeric acid. The residue in the flask (B) contained a tarry substance and apoturmeric acid, which not infrequently separated in white crystals as the solution cooled.

Upon distilling with steam the solution left after extraction with ether it yielded a strongly acid distillate containing a little of the yellow oily acid, from which it was freed in great part by extracting it five times with ether. It was then boiled with baric carbonate to convert it into a barium salt, which crystallised, after it had evaporated spontaneously nearly to dryness. The crystals, freed from mother-liquor by pressure between filter-paper, were nearly pure baric acetate, as shown by the following analysis:—

1·1745 grms. of the air-dried salt lost 0·0661 grm. when dried at 100°.

	Calculated for $Ba(C_2H_3O_2)_2H_2O$.	Found.
Water	6·59	5·63

1·1038 grms. of the dried salt gave 0·9974 grm. of baric sulphate.

	Calculated for $Ba(C_2H_3O_2)_2$.	Found.
Barium	53·73	53·13

As, however, a solution of the silver salt blackened much more easily than argentic acetate should, and crystallised at first in balls made up of radiating needles, although after one or two re-crystallisations attended by blackening it gave the flattened needles characteristic of argentic acetate, we suspected that there might be some other acid present, the barium salt of which had been removed in the mother-liquors, and resorted to fractional acidification with sulphuric acid to settle this point. For this purpose a quantity of the acid distillate, after treatment with ether, was converted into the calcium salt and treated with one-third of the amount of sulphuric acid necessary to set free all the acid it contained. It was then distilled with steam as long as the distillate showed an acid reaction. The residue in the flask was treated twice successively with the same amounts of sulphuric acid, and the first and third fractional distillates converted into calcium salts.

I. 0·3582 grm. of salt from the first fraction gave 0·2894 grm. of calcic sulphate.

II. 0·2281 grm. of salt from the third fraction gave 0·1980 grm. of calcic sulphate.

	Calculated for $Ca(C_2H_3O_2)_2$.	Found. I.	Found. II.	Calculated for $Ca(C_3H_5O_2)_2$.
Calcium ..	25·32	23·76	25·54	21·50

From these numbers it appears that there is no large amount of any acid except acetic present, and the blackening and different crystalline forms of the silver salt were probably due to a trace of turmeric acid which could not be removed by ether.

As it was possible that a neutral lactone might have been formed, a portion of the acid liquid was boiled with baric carbonate, distilled with steam, and the neutral distillate boiled with baric hydrate for some time; as after removing the baric hydrate with carbonic dioxide there was no residue on evaporation, no lactone was formed.

The formation of carbonic dioxide was determined by a special experiment, in which a portion of turmerol was oxidised out of contact with the air; upon acidifying with sulphuric acid a gas was given off, which gave a copious white precipitate with lime-water.

A. *Study of the Distillate obtained from the Ether Extract with Steam.*

This consisted principally of water, with a few yellow or brown oil-drops floating in it. It was extracted with ether, and the extract, which had acid properties, boiled with water and calcic carbonate. The solution of a calcium salt thus obtained, when allowed to evaporate spontaneously, deposited spherical collections of white needles and a yellow viscous substance somewhat more soluble than the crystals.

The crystalline body proved to be the calcium salt of the new acid, which we have called turmeric acid, after it had been purified by repeated crystallisation from water, which is tedious in the highest degree, as all the solutions and evaporations have to be carried on at ordinary temperatures; in fact, it took us more than a year and a half to prepare and purify the 4 or 5 grms. of this substance which have served for the present research.

In regard to the nature of the viscous non-crystalline salt we cannot speak with certainty, as we were unable to obtain it free from calcic turmerate; but we are of the opinion that it is a salt of an isomeric acid, as an analysis of the salt, which had not been purified by crystallisation, gave 8·12 per cent of calcium instead of 8·93 calculated for calcic turmerate, and the acid set free from the amorphous salt remained liquid even at −5°, while turmeric acid solidifies at ordinary temperatures.

The total yield of mixed calcium salts cannot be more than 1 or 2 per cent of the turmerol oxidised, and the proportion of amorphhus salt in this product is comparatively small.

Turmeric Acid, $C_{11}H_{14}O_2$.—The calcium salt prepared and purified as just described was treated with hydrochloric acid, and then extracted with ether. On evaporating off the ether a yellowish oil was left, which crystallised on standing, and gave the following analytical results after being dried *in vacuo*:—

I. 0·2198 grm. of substance gave 0·5954 grm. of carbonic dioxide and 0·1586 grm. of water.

II. 0·1320 grm. gave 0·3584 grm. of carbonic dioxide and 0·0960 grm. of water.

	Calculated for $C_{11}H_{14}O_2$.	Found. I.	Found. II.
Carbon	74·16	73·87	74·04
Hydrogen	7·86	8·02	8·08

Properties.—The turmeric acid, as at first precipitated, is an oil which gradually solidifies in long white branching needles, or crystalline masses, with a faint smell like cocoanut; freed from oil by pressing between the filter-paper it melts at 34° to 35°; it is slightly soluble in water, very freely in all the other common solvents except methyl alcohol, in which, however, it is readily soluble, so that it was found impossible to crystallise it from this or any other solvent; it distils slowly with steam, and is a monobasic acid. When oxidised with a hot solution of potassic permanganate, not in too great excess, it gives the apoturmeric acid, which will be described later in this paper.

Calcic Turmerate, $Ca(C_{11}H_{13}O_2)_2.3H_2O$.—The preparation and purification of this salt have been described in connection with the manufacture of turmeric acid. For analysis it was dried, at first *in vacuo*, and afterward at 100° or 110°, when several agreeing analyses gave the percentage of calcium 10·78 to 11·13, whereas calcic turmerate contains only 10·15 per cent of calcium. This led us to suspect that the salt had undergone a constant decomposition at this temperature, which we were the more inclined to do because at first it lost weight very rapidly, but later the loss dropped to a few milligrammes a day, and more than a week of continuous heating was necessary to obtain a constant weight, while at the same time the salt gradually became brown and viscous. We have therefore calculated our results upon the salt dried *in vacuo*, and these agree very well with the amount of calcium in calcic turmerate containing three molecules of water of crystallisation.

I. 0·3131 grm. of substance dried *in vacuo* gave 0·0970 grm. of calcic sulphate.

II. 0·2993 grm. gave 0·0912 grm. of calcic sulphate.

	Calculated for $Ca(C_{11}H_{13}O_2)_2.3H_2O$.	Found. I.	Found. II.
Calcium	8·93	9·11	8·96

Properties.—It forms spherical collections of white radiating needles looking like chestnut-burrs; the purer the salt the more distinct are the separate needles. When boiled with water it melts to a viscous mass, which is then acted on by the water only very slowly; it is therefore advisable to dissolve it in the cold.

7·861 grms. of the solution saturated at 16° gave 0·0344 grm. of calcic sulphate. Therefore a saturated solution at 16° contains 1·27 per cent of $Ca(C_{11}H_{13}O_2)_2$.

The salt is also soluble in alcohol, and is decomposed by a heat of 100° to 110°, as already stated.

The behaviour of a solution of the calcium salt with various reagents was also studied, and it was found to give a white flocculent precipitate with aluminic chloride; a similar reddish brown precipitate with ferric chloride; heavy white precipitates with mercurous or plumbic salts, the plumbic salt melting under boiling water, and forming, when prepared in quantity, an uninviting yellowish viscous mass; cupric nitrate produced pale blue flocks, and argentic nitrate a heavy white precipitate somewhat soluble in water; the other common reagents gave no characteristic precipitates.

An attempt was made to prepare and analyse the *silver salt*, but we did not succeed in purifying it, since its solubility in water is so great that the impurities could not be removed by washing without using a larger amount of substance than was at our disposal; and it was impossible to re-crystallise it from water, as its solutions decomposed with great ease. An imperfectly washed specimen gave a result which approaches that required by theory.

0·1932 grm. of the salt dried *in vacuo* gave 0·0750 grm. of silver.

	Calculated for $AgC_{11}H_{13}O_2$.	Found.
Silver	37·89	38·82

The *barium salt* resembled the calcium salt in that it formed little balls of radiating needles, but showed a much greater tendency to separate in a viscous state, so that it was hard to obtain it crystallised.

The behaviour of the *zinc salt* is very characteristic. When a solution of it is prepared by boiling the acid with water and zincic oxide, allowing the liquid to cool, and filtering, the clear solution thus obtained becomes turbid, when warmed even to temperatures far below the boiling-point, but clears up again as the liquid cools. The salt could be obtained only as a viscous mass.

B. *Study of the Residue from Distillation with Steam.*

The flask-residue, after the turmeric acid had been distilled off with steam, contained a black tarry substance,

and not infrequently a white crystalline acid, which can be separated from the tar by treatment with boiling water. On extracting with ether the aqueous mother-liquor, from which the white acid had crystallised, a third substance, yellow and buttery, was obtained. All these substances are acids, but we have been unable to bring the black tarry acid or the yellow buttery one into a state fit for analysis, and can only say that the very ill-defined calcium salt of the former contained 1·69 per cent of calcium, while the latter gave on oxidation an acid melting near 180°, which was not phthalic acid, and was formed in such small quantity that we were unable to determine whether it was a pure substance or only a mixture of apoturmeric acid with some impurity.

Apoturmeric Acid.—The white crystalline acid was separated from its impurities by crystallisation from boiling water, till it showed a constant melting-point. The same acid is obtained by oxidising calcium turmerate with a hot solution of potassic permanganate, and a good part of the substance used for analysis was prepared in this way. The yield, however, was so small, not over 10 per cent of the turmeric acid used, that we have been unable to determine even its formula with certainty, as will be seen from the following analyses.

0·1138 grm. of substance gave 0·2582 grm. of carbonic dioxide and 0·0590 grm. of water.

	Calculated for $C_{10}H_{10}O_4$.	Found.	Calculated for $C_{10}H_{12}O_4$.
Carbon ..	61·86	61·87	61·22
Hydrogen .	5·15	5 76	6·12

The *calcium salt* made by boiling the acid with calcic carbonate and water gave the following results :—

I. 0·2274 grm. of salt dried *in vacuo* lost 0·0304 grm. when heated to 100°.

II. 0·1390 grm. lost 0·0186 grm. when heated to 100°.

	Calculated for $CaC_{10}H_8O_4 2H_2O$.	Found. I.	Found. II.	Calculated for $CaC_{10}H_{10}O_4 2H_2O$.
Water .	13·43	13·36	13·39	13·33

0·1826 grm. gave 0·3370 grm. of carbonic dioxide, 0·0758 grm. of water, and 0·1016 grm. of calcic sulphate.

	Calculated for $CaC_{10}H_8O_4$.	Found.	Calculated for $CaC_{10}H_{10}O_4$.
Carbon ..	51·72	50·32	51·29
Hydrogen .	3·40	4·61	4·27
Calcium ..	17·24	16·36	17·10

The *barium salt* prepared like the calcium salt gave a result which is not in harmony with the preceding.

0·2704 grm. of salt dried at 100° gave 0·1742 grm. of baric sulphate.

	Calculated for $BaC_{10}H_8O_4$	Found.	Calculated for $BaC_{10}H_{10}O_4$.
Barium ..	41·64	37·87	41·39

If, however, we suppose that the salt retained two molecules of water at 100° the result agrees very well with the calculated per cents.

	Calculated for $BaC_{10}H_8O_4 2H_2O$.	Found.	Calculated for $BaC_{10}H_{10}O_4 2H_2O$.
Barium ..	37·53	37·87	37·32

But this supposition is, to say the least, improbable, as the calcium salt loses its water easily at 100°; unfortunately, we did not have enough of the acid to repeat the analysis of the barium salt.

Properties.—The apoturmeric acid separates from its solution in boiling water as a white, rather stiff, woolly mass, which renders the whole solid if the solution was a strong one. It melts at 221°, and is easily soluble in alcohol, ether, and boiling water; nearly insoluble in cold water.

Ammonic apoturmerate is not very freely soluble, and gives the following characteristic precipitates :—With plumbic acetate, white flocculent; with cupric sulphate, whitish green,—both soluble in an excess of the precipitant; with mercurous nitrate, white flocks; with ferric chloride yellowish white; with argentic nitrate, a heavy white precipitate, slightly soluble in boiling water. With the other common reagents it gives no precipitates at all, or very slight white ones.

Several attempts were made to oxidise the apoturmeric acid, but they gave no satisfactory result. The acid was attacked only with difficulty either by potassic permanganate or chromic anhydride, and the only insoluble substance left after the oxidation was simply undecomposed apoturmeric acid. In no case have we observed the formation of terephthalic acid from apoturmeric, or from carefully purified turmeric acid; but this acid has appeared when a calcic turmerate containing the non-crystalline impurity was oxidised. We should therefore ascribe the formation of terephthalic acid from turmerol by violent oxidation rather to this substance than to the turmeric acid formed; but our experiments must be repeated on a larger scale before we can consider this point finally settled.

It is to be regretted that we were unable to settle definitely the composition of the apoturmeric acid, as this would have thrown much light on the constitution of turmeric acid; as it is, it is not worth while to advance any hypotheses on this subject.

We may add one more observation in reference to turmerol, viz., isobutyl-turmerol does not give an addition-product with bromine, but there is formed with evolution of hydrobromic acid a most uninviting unstable viscous oil.—*American Chemical Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcviii., No. 26, June 30, 1884.

The Use of Formene for Obtaining very Low Temperatures.—L. Cailletet.—Formene or marsh-gas if slightly compressed and cooled in boiling ethylene under atmospheric pressure becomes a colourless and extremely mobile liquid, which, on returning to the gaseous state, gives a cold sufficient to liquefy oxygen immediately.

On Chemical Compounds obtained by means of a Gas Battery and of Effluve Apparatus.—A. Figuier.—From carbon monoxide and dinoxide the author has obtained oxalic and formic acids. The same two acids have been obtained from carbon monoxide and sodium carbonate, from ethylene and oxygen, and from hydrogen and carbonic acid.

Conversion of Liquid Batteries into Dry Batteries.—M. Onimus.—The author mixes the exciting liquid with gypsum, which is then allowed to solidify, and which may then be either used alone or mixed with manganese peroxide or ferric oxide.

The Coagulation of Colloidal Bodies.—E. Grimaux.—The coagulation of the colloids is not an obscure or unexplained phenomenon. It depends on chemical equilibria such as are observed in etherification and dissociation.

Preparation of Hydrated Chromic Acid, and certain New Properties of Chromic Anhydride.—H. Moissan.—Chromic anhydride absorbs hydrochloric acid at ordinary temperatures, producing abundant red fumes, which condense into chloro-chromic acid. Hydrobromic and hydriodic acids under the same circumstances do not furnish analogous chrome compounds. Chlorine when absolutely dry does not attack chromic anhydride.

Production of Neutral Crystalline Aluminium Orthophosphate.—A. de Schulten.—To a concentrated solution of sodium aluminate the author adds phosphoric acid until the mixture is strongly acid, and heats the whole for some hours to 250° in a sealed tube. There is formed an abundant deposit of small hexagonal prisms, which are absolutely pure if a sufficiency of phosphoric acid has been used.

A New Alcohol Extracted from Bird-lime.—M. J. Personne, jun.—The composition of the compound in question is $C_{50}H_{44}O_2$. It is an alcohol, and if treated with acetic anhydride it yields an acetic ether, the melting-point of which is between 204° to 206°.

On Colchicine.—M. S. Zeisel.—Dilute mineral acids split up colchicine into *colchiceine* and methylic alcohol. Colchiceine, if treated with strong mineral acids at 110° to 120°, yields a new base, apocolchiceine, along with methylic alcohol and acetic acid.

Detection and Determination of Small Quantities of Carbon Disulphide in Air, Gases, the Sulpho-carbonates, &c.—M. Gastine.—The reaction proposed consists in passing air containing vapours of carbon disulphide into an alcoholic solution of potassa. Potassium xanthate is formed. The alcoholic solution of potassa should be prepared with absolute alcohol and potassa recently fused, for even a trace of water much reduces the sensitiveness of the reagent. For the same reason the gas or air in question is dried. The alcoholic liquid is neutralised with acetic acid, and the presence of xanthic acid is shown by adding a drop of copper sulphate. There is formed copper xanthate, insoluble in water and of a fine yellow colour.

Processes used in Determining Phosphoric Acid in Superphosphates.—E. Aubin.—In presence of mixtures like the superphosphates it is rational to extract the soluble matter completely with water before employing ammonium citrate. Another error is often committed by not determining the quantity of ammonium-magnesium phosphate which remains in solution in liquids containing large proportions of ammonium citrate.

Power of Cultivated Wine Yeast.—Alph. Rommier.—The author proposes to add to the juice of the pressed grapes the ferment of wine purified by systematic cultivation,

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Zeitschrift für Analytische Chemie.
Vol. xxiii., Part 1, 1884.

Determination of Specific Gravity by means of the Pyenometer.—S. Pagliani.—If the instrument consists of very thin glass even a slight pressure on the bottom of the instrument affects its shape and consequently its level.

An Increase of the Proportion of Oxygen in Air.—According to the *Laterna Magica* this may be effected by aspirating a current of air through several layers of taffeta which have been plunged in alcohol or carbon disulphide, and then coated with a thin layer of caoutchouc. After passing through four such layers the proportion of nitrogen in the air is said to be reduced to 5 per cent.

A Reagent for the Potassium Compounds.—Giacomo Campari.—The author uses bismuth-sodium hyposulphite, which, in contact with potassium salts, forms the corresponding potassium double salt, perfectly insoluble in strong alcohol and of a bright lemon-yellow colour. The reagent is prepared by dissolving 1 part of basic bismuth oxide in a minimum of hydrochloric acid at common temperatures. In the meantime two parts of crystalline sodium hyposulphite are dissolved in a minimum of water, and each is brought to a volume equal and as small as possible. When wanted for use two or three drops of each are mixed and diluted with 5 c.c. of alcohol, thus forming the reagent in question.

Reactions of Uranous Salts.—C. Zimmermann.—These reactions are inaccurately stated in many text-books owing to experiments made upon uranous salts containing uranic oxide. Potassa or soda gives a bulky, pale green precipitate, insoluble in excess. It quickly changes if exposed to the air, first to black-brown urano-uranic hydroxide, and then to yellow potassium- (or sodium-) uranic oxide. Ammonia acts in a similar manner. Alkaline carbonates give a greenish white precipitate which becomes dark if heated. Bicarbonates give the same precipitate, but soluble in excess. If heated, it is partially oxidised and re-precipitated. Ammonium carbonate gives a greenish white precipitate, readily soluble in excess and not re-precipitated on heating. Potassium ferrocyanide gives a yellowish green precipitate, which gradually turns to a reddish brown. The ferrocyanide gives at once a reddish brown precipitate. In presence of tartaric acid, ammonia, ammonium sulphide, and the fixed alkalies give no precipitate, and the liquid does not take a dark colour. Ammonium sulphide gives a light green precipitate, which quickly becomes dark brown and turns black if boiled. Barium carbonate completely precipitates uranous salts even in the cold.

Method for Determining Manganese Peroxide in Commercial Pyrolusite.—J. W. Chalmers Harvey.—From the Chemical News.

Solubility of Lead Sulphate in Basic Lead Acetate.—K. Stammer.—If in a moderately strong solution of a sulphate a precipitate of lead sulphate is produced by adding basic lead acetate, it re-dissolves completely on adding an excess of the latter salt. If acetic acid is then added the lead sulphate is re-precipitated.

—A Reaction of Mercuric Chloride.—H. Debray.—If to an aqueous solution of mercuric chloride there is added a large excess of sodium chloride, the mixture, after treatment with sulphurous acid, may be heated to boiling without the precipitation of mercurous chloride.

The Electrolytic Determination of Copper.—J. B. Mackintosh criticises in the *American Chemical Journal* Luckow's well known process. Luckow replies that he adds tartaric acid only in the specific case of the Mansfield cupriferous shales to obviate the disturbing action of the manganese, and maintains that the electrolytic precipitation of copper from solutions containing nitric acid is quite practicable if any lower oxides of nitrogen are previously expelled and a moderate constant current is kept up.

Determination of Phosphoric Acid.—H. Pemberton, Jr.—From the Chemical News.

Determination of Phosphoric and Molybdic Acids in the Phospho-Molybdates.—Wolcott Gibbs.—From the *American Chemical Journal.*

Detection of the Hydracids of Chlorine, Bromine, Iodide, Cyanogen, Ferro- and Ferri-cyanogen, and of the Chloric, Bromic, and Iodic Acids.—A Longi.—From the Chemical News.

Determination of Small Quantities of Nitrous Acid in a Free or Combined State.—E. J. Davy.—From the Chemical News.

Detection of Urea in Aqueous Solutions.—C. L. Bloxam.—From the Chemical News.

Detection of Aldehyds and Ketones.—E. Nageli.—Already inserted from the *Berichte der Deutsch. Chem. Gesell.*

New Reaction for Aldehyds.—F. Petzoldt and E. Fischer.—From the *Berichte der Deutsch. Chem. Gesell.*

Qualitative Reaction of Acetal.—M. Grodzki.—From the *Berichte der Deutsch. Chem. Gesell.*

Reaction of Eugenol.—Klunge.—If eugenol, or any ethereal oil in which it is present, is heated with double its volume of sulphuric acid (undiluted) for a short time in the water-bath, diluted, digested with barium carbonate until neutral, filtered, and mixed with ferric chloride, there is formed a deep blue solution. To avoid confusion with salicylic acid Klunge recommends to add to a few drops of the oil suspended in water a few drops of ammonium car-

bonate and a small fragment of ferrous sulphate. If eugenol is present the drops of oil turn violet.

The Presence of Caffeine in Cacao.—E. Schmidt.

On Gelsemine.—A. W. Gerrard.—From the *Pharmaceutical Journal.*

The Quinine Reaction with Potassium Ferrocyanide.—A. Vogel.—The author recommends to use the reagents always in the following order:—Bromine water (in place of chlorine water), ferrocyanide, and then borax, in place of ammonium carbonate.

Solubility of the Strychnine Salts in Acids.—Hanriot and Blarey.—From the *Comptes Rendus.*

Determination of the Halogens in Organic Compounds.—E. Mulder and A. S. Hamburger.—In determining the halogens by ignition with caustic lime the authors make use of a lime obtained by igniting precipitated calcium carbonate in a current of pure hydrogen. This process is continued until baryta water is no longer rendered turbid by the escaping gas. They heat the substance mixed with such lime in a tube 0·6 centimetre in width and 30 c.m. in length, and attach, in order to observe the progress of the analysis, a small U-tube with silver nitrate.

Determination of Halogens in Volatile Organic Compounds.—R. T. Plimpton and E. E. Graves.—From the *Journal of the Chemical Society.*

The Quantitative Determination of Methyl-Aldehyd.—L. Legler.—From the *Berichte der Deutsch. Chem. Gesell.*

Behaviour of Dextrose with Ammoniacal Solution of Silver containing Caustic Soda.—B. Tollens.—From the *Berichte der Deutsch. Chem. Gesell.*

Preparation of Glucose by the Schwarz-Neubauer Process, and its Determination with Knapp's Solution.—Worm Müller.—From the *Journal f. Prakt. Chemie.*

Determination of Starch in Grain.—G. Francke.—The author heats in sealed tubes with water in presence of a trace of lactic acid.

Determination of Chloride of Lime in Water.—Anthony A. Nesbit.—This paper appeared originally in the CHEMICAL NEWS, but is by mistake credited to the *Pharm. Central. Halle.*

Examination of Milk.—A. Jörgensen.

Determination of the Fat in Milk.—C. H. Wolff.—To 50 c.c. milk the author uses 3 c.c. of potassa lye (sp. gr. 1·145) and 54 c.c. of aqueous ether. The mixture is well shaken up at 17° to 18°; 20 c.c. of the ethereal solution are drawn off with a pipette, evaporated in a tared flask, and weighed.

Examination of Butter.—J. Zanni.—The author shows that certain butters are mixed with butyric acid in order to increase the relative proportion of the soluble acids and decrease that of the insoluble. Such butter is sold in Constantinople as Siberian butter.

A New Adulterant for Lard and Butter.—J. Muter.—From the *Analyst.*

Caffeine in Cacao.—E. Schmidt.—The author proposes to separate caffeine from theobromine by making use of their different solubility in cold benzol.

Examination of Rum.—E. List.—The author finds formic acid constantly present.

Detection of Free Mineral Acids in Vinegar.—Wharton.—The author evaporates down to a syrup, lets cool to a hand heat, and stirs in a few centigrammes of potassium chlorate. If there is more than 1 per cent of sulphuric acid the mass ignites violently. Smaller quantities are detected by the odour of chlorine.

Vermicelli Coloured with Aniline Yellow.—Mercier and Bertherand.—The colour is almost instantly destroyed by dilute sulphuric acid, whilst the colour of saffron is attacked.

Distinction between Rice-Meal and the Meal of Buckwheat.—A. Lehn.—The sample is made into a paste with strong potash-lye, heated on the water-bath, and treated with hydrochloric acid. In case of rice the paste is yellow, and after treatment with acid, white. Buckwheat gives a dark-green paste which is turned red by hydrochloric acid.

Is a Colour fixed in the Fibre or Printed on with Albumen?—R. Meyer.—Already inserted.

Detection and Determination of Picric Acid.—G. Christel.—This paper will be inserted in full if possible.

Detection of Solar Oil in Petroleum.—Solar oil raises the specific gravity and the boiling-point of the mixture. Copper butyrate dissolves in both with a bluish green colour. But if the solution is heated to 210° it remains, in case of pure petroleum, green and clear. Solar oil becomes yellow at 120°, and deposits yellow flocks.

Determination of Ammonia in Gas-Liquor.—Knublauch.—The author puts 100 c.c. in a half litre flask, fills up to the mark with water, and shakes well. He puts some of this water into a stoppered bottle, so as to occupy two-thirds of its capacity, adds a few fragments of quicklime, and lets stand for an hour, shaking frequently; 50 c.c. of the filtrate are titrated with an acid, using rosolic acid as an indicator.

Value of Isinglass.—F. Prollius.—The author determines ash, moisture, matter insoluble in water, viscosity of solution, and examines microscopically.

Distinction between Oils of Cinnamon and Cassia.—Woodland.—From the *Pharm. Journal.*

Detection of Cotton Oil in Olive Oil.—E. Becchi.—Five c.c. of the sample are mixed in a glass flask with 25 c.c. of alcohol at 98 per cent, and 5 c.c. of a reagent made by dissolving 1 grm. silver nitrate in 100 c.c. alcohol at 98 per cent. The flask is then heated to 84°. If even a trace of cotton oil is present it takes a dark colour.

Apparatus for Determining the Air in Carbonic Acid.—J. Sohnke.—The apparatus is not here described.

Determination of Chromium in Iron and Steel.—J. O. Arnold.—From the CHEMICAL NEWS.

Detection of Suint in Tallow.—L. Meyer.—This paper will be given in full if possible.

Rapid Determination of Fatty Acids and Alkali in Soaps.—M. Pinchon.—The author effects this process by means of a small burette, capable of being closed above, and fitted with a tap below. He introduces 5 c.c. normal hydrochloric acid, introduces 1 grm. of the soap in thin shavings, and 8 to 10 c.c. ether. He then closes the burette above and shakes well from time to time. When the decomposition is complete the lower watery stratum is run off, drop by drop into a beaker, the ethereal solution is washed with water until the latter has no longer an acid reaction, and rinsed with ether into a flat-bottomed porcelain capsule. The ether is evaporated at common temperatures under a funnel, the residue dried and weighed. The alkali is determined by titrating back the acid solution.

Determination of Sugar in Beets.—P. Degener.—This paper does not admit of useful abstraction.

Occurrence of α Oxyglutanic Acid in Molasses.—E. v. Lippmann.—From the *Berichte der Deutschen Chem. Gesell.*

Examination of Basic Bismuth Nitrate for Arsenic.—Th. Salzer.—A critique on the method recommended in the *Pharmacopœia Germanica.*

Determination of Iodine in Urine.—F. Pecirka.—The author has examined Hilger's method and finds that the results are invariably too low.

Detection of Mercury in Urine.—V. Lehmann.—The author gives the preference to Mayer's method.

New Process for the Determination of Urea.—L. Hugounenq.—From the *Comptes Rendus.*

Presence of Acetacetic Acid in Urine.—R. v. Iaksch.—The author fully proves the occurrence of this acid in urine.

Determination of Uric Acid.—E. A. Cook.—From the *British Medical Journal*.

Detection and Approximate Determination of Sugar in Urine.—G. Johnson.—From the *British Medical Journal*.

On Hemi-albumose in Urine.—This compound is obtained by the action of digestive ferments or boiling acid upon various albumenoids, and seems to occupy in its position and properties a medium place between the two albumenoids and the peptones.

Detection and Determination of Albumen in Urine. A. B. Haslam.—From the CHEMICAL NEWS.

Chemico-Legal Detection of Hydrocyanic Acid.—R. Otto.—For the detection of hydrocyanic acid or potassium cyanide in presence of the non-poisonous double cyanides Beckurts and Schoenfeldt recommend a modification of the methods of Jacquemin and Barfoed.

Luminosity of Phosphorus in Mitscherlich's Apparatus.—According to Schwanert this luminosity is prevented by the presence of salts of lead.

Formation of Arsenic Hydride by Fungi.—C. Bischoff.—The author suggests that this reaction may be the cause of the peculiar kakodyle-like odour experienced on exhuming old arseniferous dead bodies, and not met with under any other circumstances.

Permanence of the Spectroscopic Reaction of Carbon Monoxide.—C. H. Wolff.—Blood saturated with carbon monoxide in well-filled stoppered bottles retains its properties for years.

The Equivalent Weights of Bismuth, Manganese, Zinc, and Magnesium.—C. Marignac.—The author's purpose was to ascertain whether the oxides of these metals, which have hitherto been regarded as homogeneous, might, like the oxides from cerite, prove on fractionated precipitation to be mixtures. He finds that this is not the case. For bismuth he finds as a mean result the weight 208·16; for manganese, 55·07; zinc, 65·43, and magnesium, 24·38.

The Equivalent Weights of Lanthanum, Didymium, Decipium, and Samarium.—If O=16 and didymium oxide Di_2O_3 the determination of Cleve are 147 and 142·12; those of Brauner 146·58 and 145·42. For lanthanum, assuming its oxide to be La_2O_3, Marignac gives the value 138·81, Cleve 139·15 and 138·22, and Brauner 138·88 and 138·28. For decipium, supposed to form a sesquioxide, Delafontaine gives 171. For samarium we have, according to Marignac, 149·4; according to Delafontaine, 151·5; and Cleve, 150·021.

Journal für Praktische Chemie.
New Series, Vol. xxix., Part 1.

Products of the Action of Phosphorus Pentachloride upon Komenaminic Acid.—Dr. Theodor Bellmann.—On allowing 5 mols. of the pentachloride to act upon 1 mol. of komenaminic acid at temperatures of 220°, 250°, and 275° the author obtains a mono-chloroxy-acid which he designates as mono-chlor-*y*-oxy-picolic acid. An account of its derivatives follows. From the mother-liquor the author obtains mono-chlor-kyamic acid. He next examines the action of 3 mols. phosphorus pentachloride upon 1 mol. komenaminic acid at 200°. Among the products is methyl-oxy-pyridone, $C_6H_7NO_2$. The behaviour of this compound with bromine, with hydriodic acid, and with phosphorus pentachloride is further investigated.

Chemico-Critical Passages.—Herman Kolbe.—These papers are incapable of useful abstraction, but are well worthy of thoughtful perusal.

On Fractionated Distillation in a Current of Steam as a New Method for Examining the Components of Mineral Oil.—Faustin Ras nski.—A preliminary notice. The raw material which the author employs is the so-called astraline (sp. gr. 0·831) obtained from the petroleum of Baku.

A Reply.—F. Salomon.—The author defends himself against certain criticisms of Musculus. (See *Journal fur Praktische Chemie*, vol. xxviii., pp. 84 and 496).

Action of Epichlorhydrine upon Diethylamine.—M. Reboul.—From the *Comptes Rendus*.

Vol. xxix., Part 2.

Determinations of Chemical Affinity.—Dr. W. Ostwald.—The author examines the solubility of potassium bitartrate and of barium, strontium, and calcium sulphates. The values of the affinities appear as constants, which determine the chemical action quantitatively. This result unites in a peculiar manner the two opposite theories of affinity of the last century.

The Nitrogenous Derivatives of Meconic Acid.—H. Ost.—The author describes a number of oxy-pyridines and oxy-pyridine-carbonic acids.

Studies on Milk.—H. Struve.—We have here an account of α- and β-caseine, and of the albumen and peptone of milk.

The Use of Boiling Oxygen as Refrigerating Agent, the Temperature thus obtained, and the Solidification of Nitrogen.—S. v. Wroblewski.—The author is in doubt whether the crystalline precipitate which remains when liquid oxygen evaporates consists of pure crystals of oxygen, or is derived partly, or entirely, from possible impurities of the gas. Another circumstance which makes the use of liquid oxygen difficult as a refrigerating agent is the necessity of experimenting in closed, very strong vessels. The temperature of boiling oxygen is approximately −186°. Nitrogen compressed in a glass tube, refrigerated in a current of boiling oxygen, and then re-expanded, falls down in snow-like flakes, consisting of crystals of remarkable size.

Moniteur Scientifique, Quesneville.
Vol. xiv., July, 1884.

Chemical Products at the Swiss National Exhibition of 1833.—Dr. G. Lunge.—The only Swiss establishment which produces the mineral acids and the alkalies is that of Schnorf Brothers, at Uetikon, on the Lake of Zurich. Most of the chemical works in the cantons are occupied with the production of colours, mordants, and other preparations used in connection with textile manufactures.

On the Chemistry and the Analytical Examination of the fixed Oils.—A. H. Allen.—From the *Journal of the Society of Chemical Industry*.

Contribution to the Study of the Artificial Blue Colours, with Reference to Wool-dyeing.—W. Rospendowki.—A very important paper, which we hope to reproduce in full.

The Industrial Society of Mulhouse; Meetings of the Chemical Section.

April 19th.—M. Procharoff and M. Schmid gave an account of the preparation and use of canarine (cyanogen persulphide).

M. Camille Kœchlin submitted specimens of two new yellows, flavaniline, a dye for silks and woollens and which works best with an equal weight of tartaric acid and magnesium acetate, and auramine, which is applicable on wool and on cotton, and which to be fixed on the latter requires an equal weight of tartaric acid, six parts of tannin, and a passage in tartar-emetic, after steaming.

May 14.—M. A. Scheurer presented a note on discharges on indigo by means of gaseous chlorine. Chlorine,

even when moist, destroys indigo only slowly; but if caustic alkali, thickened, is printed on the indigo, the discharge by gaseous chlorine is immediate. It is the same with Turkey-reds. Coloured discharges may be produced in the same manner on blue or red grounds. If there is printed a mixture of lead oxide and chrome oxide dissolved in soda the synthesis of lead chromate is effected, the blue is destroyed, and a yellow discharge is produced. For red discharges on indigo a very alkaline sodium aluminate is printed on, the pieces are taken through chlorine, then dunged and dyed in alizarin.

The Transformation of the Theory of Atoms.—M. Victor Meyer.—Already noticed.

Remarks on a Recent Memoir by M. Hesse.—M. Grimaux.—A reclamation of priority with reference to a memoir on morphine published in Liebig's *Annalen*, Dec. 22, 1883.

Bulletin de la Société Chimique de Paris.
No. 10, May 20, 1884.

On Anthemene. Researches on Roman Camomile.—M. Laurent Naudin.—The author has succeeded in separating and purifying the two bodies which he described at the meeting of the *Société Chimique*, July 13th, 1883, and has completed the examination of the one which melts at 63° to 64°. It boils at 440° in the vapour of sulphur without apparent decomposition, and has the sp. gr. 0·942 at 15°. It is insoluble in water, soluble in ether, petroleum, carbon disulphide, and chloroform. It dissolves in absolute boiling alcohol, but it is almost entirely re-deposited on cooling.

Quantities of Heat Liberated during the Compression of Solid Bodies.—W. Spring.—The author's experiments show that the compression of a solid body does not liberate such quantities of heat as it has been thought. He considers, therefore, the chemical combinations produced under pressure are due not to the heat developed during compression, but simply to the intimate contact which pressure occasions between the solid particles of the elements mixed.

Quantities of Sulphides formed by the Successive Compressions of their Elements.—W. Spring.—The experiments described show that pressure occasions under certain conditions the mutual combination of solid bodies. The quantity of the compound produced depends at once on the magnitude of the surfaces of contact of the elements and on the duration of the contact. The phenomena of combination under pressure approximate in their nature to the slow combinations produced under certain conditions. Thus a piece of sodium exposed to the action of dry air is slowly oxidised, although its temperature is below the point of ignition properly so-called. In like manner silver brought forcibly into contact with sulphur passes slowly into the state of sulphide without a sensible rise of temperature. Hence, if a mixture of solid bodies in powder is submitted to a single and brief compression the result will be very imperfect. Accordingly pressure is not a chemical agent of the same kind as heat or electricity.

Researches from the Laboratory of the Chemical School of Mulhouse.—These consist of a memoir by MM. E. Noelting and G. de Bechi on the constitution of phthalyl chloride; a memoir by Noelting on phenols of a high boiling-point contained in coal-tar; and another paper by the same author on nitro-benzyl chloride.

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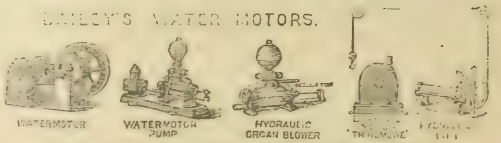

Silver Medal, Manchester, 1879; *Blackburn*, 1881.

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The 4-horse Water-Motor is at work Cutting Timber, by circular saw, 5 inches thick.
A 20-horse Water Motor, pumping for H. Vivian, Esq., M.P.
A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

June 22, 1881.—From H. H. Vivian, Esq., M.P.—"I have just heard that the Water Motor sent out last year is doing well."
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THE CHEMICAL NEWS.

Vol. L. No. 1290.

PASTEUR AND THE GERM THEORY.*

By FREDERICK J. FARADAY, F.L.S.

1. I have been encouraged by Dr. Angus Smith to present to you a *résumé* of some of the most remarkable results of the experimental development of what is known as the germ theory. In carrying into effect this idea it will not be expected that I should restrict my attention to Pasteur's work. There have been many able workers besides Pasteur in this field of biological investigation. But the work done by Pasteur is so original and important that he may well be regarded as the great leader of the school; and such other work as it may be desirable to refer to can be most conveniently dealt with as bearing upon his researches. I have no new microbe to show you, nor have I succeeded in demonstrating the mutual convertibility of any known species. I have, however, given considerable attention to the literature of the subject, and it has appeared to my kind sponsor, as a member of this Society, that a special presentation of such of the facts as have grouped themselves together in my mind, and of some of the thoughts which have been spontaneously evolved from these groupings, might not be without utility. It may provoke what may be considered at the present juncture as a timely discussion, which may bring into clear outline the frontier points of one of the most profound and practical series of enquiries which have ever fascinated scientific men or exercised the human intellect. It is very probable that the paper may take a more philosophical turn than will be in keeping with the exact scientific character of the papers which the Society is in the habit of receiving. In extenuation I must plead that the Society is known as the Literary and Philosophical Society, and that according to the interesting centenary volume lately published by it, it has from time to time received even purely speculative communications. To follow the example of men like Percival and White may appear not entirely reprehensible.

2. It is now a couple of centuries since Leeuwenhoek communicated to the Royal Society an account of what was apparently the first discovery of bacteria. In a letter to *Nature*, Professor Cohn, a few months ago, called the attention of the scientific world to the fact that towards the close of 1683 Leeuwenhoek announced the discovery of active microscopic organisms, including bacilli, bacteriums, and vibrions. The Dutch microscopist discovered them in the white substance adhering to his teeth, and bearing in mind the important part which thermal conditions have played, or have been supposed to play, in recent experiments on the sterilisation of "culture" infusions and the "attenuation" of microbes, it is worth while to note that, failing on a subsequent occasion to perceive the movements of bacteria in the same substance, he assumed that they had been killed by the hot coffee which he had taken at breakfast. The discovery not only gave a new vitality to the discussions on spontaneous generation, both sides finding therein arguments in favour of their special opinions, but also suggested ideas as to the propagation of contagious diseases and the nature of infection. In the papers communicated to the Royal Society during the last quarter of the 17th and the 1st quarter of the 18th centuries we find most of the ideas which are still the leading ideas of micro-biologists. With reference to generation in general it is argued that the animalcule is the germ furnished only by the male, and that the female merely supplies the nidus requisite for its development. Springing from this hypothesis we have the suggestion that the nidus affects or modifies the germ, which I take to imply that, given the germ, the nidus in which it is implanted determines the species evolved therefrom. Experiments were made with rain water, mineral water, infusions of pepper-corns, bay-berries, oats, barley, and wheat, and the scum collected from these infusions was discovered to be masses of organisms. Round and elongated pulsating bodies with transparent ends and opaque centres were observed. The possibility of disease being carried from person to person by sheets, towels, handkerchiefs, gloves, &c., in consequence of minute organisms having obtained a lodgement thereon, is referred to as an inference from the fact that the minute organism of itch can live outside the body for two or three days. The existence of globular and elliptical micro-organisms in water, wine, brandy, vinegar, beer, spittle, and urine is mentioned, with the occasional though rare appearence of spots therein and central constriction; and the tendency of certain species to seek the top of the liquor apparently "for the sake of the air" is also mentioned. Small-pox is compared to fermentation, and it is suggested that it may be propagated through the air, "a bad dispositiom of the air" being favourable to its reappearance. It is suggested that the "variolous pus" when inoculated finds in the body "the native congenial variolous seeds" and ferments with them. This appears to be an inversion of the common modern doctrine which regards the inoculated matter as containing the germ and the animal body as producing the special fluid or *milieu* for its development; but it is perhaps in accordance with the ideas of Béchamp, the "native congenial variolous seeds" being possibly the micro-zymes of that inquirer.

3. These earliest speculative results of Leeuwenhoek's important discoveries cover the whole range of the latest investigations into the nature, life-history, and action of microbes, The problems then started still occupy the minds of scientific men, and it may even be said that no absolute answer has yet been given to any of them. Though Dr. Tyndall has said that the doctrine of spontaneous generation is dead, the advocates of that doctrine are prepared to maintain that the question has only been moved a stage further back. It is quite certain that the extreme members of the evolutionary school would not admit that it has been finally demonstrated that inorganic matter does not contain "the promise and potency of all terrestrial life"; indeed this is the doctrine enunciated by Tyndall himself at Belfast; and it is equally certain that even many of those who do deny that organisms capable of reproducing their species are ever evolved from absolutely unorganised matter, nevertheless do not consider the presence of any specific atmospheric or other germ as necessary for the reproduction of any given species. There is a domain which still invites the experimentalist, who may succeed in harmonising apparently antagonistic ideas. A very large and important amount of work has been done in showing the analogies between fermentation and disease, and in discovering apparently specific pathogenic microbes or ferments. Indeed, in recent years the multiplication of specific microbes has become almost embarrassing. But though strong evidence has unquestionably been adduced that, at least in certain cases, the characteristic microbe is the originator of the disease, or is capable of conveying it, the very multiplication of microbes is reviving the question as to whether these organisms are the causes or merely the accompaniments (in the sense in which the vulture is the accompaniment of carrion), or even the products of disease. The recognition of these facts does not imply any depreciation of the practical value or the significance of the work which has been done during the last thirty years, but helps us to a clearer view of its bearing and scope.

4. In considering the development of the germ theory we may pass almost directly from Leeuwenhoek and his

* A paper read before the Manchester Literary and Philosophical Society, April 15, 1884.

contemporaries to Pasteur. As a matter of history we must not of course overlook the observations of Cagniard la Tour and Schwann, based upon an observation of Leeuwenhoek, and really establishing the vegetable nature of yeast. But it is to Pasteur that we are indebted for definite progress in establishing or refuting the ideas which sprang immediately from Leeuwenhoek's discovery. The work of the Germans, and even of the French, apart from Pasteur, has been mainly in the filling up of details. Extremely important have been many of those details. The discovery of the micro-organism of anthrax by Rayer and Davaine; the subsequent discovery by Koch of the spores into which the anthrax filaments break up; Koch's discovery of the bacillus of tuberculosis; and, lastly, the same ardent investigator's latest discoveries bearing upon the nature and etiology of cholera, are all alike, not only important confirmations of previously-existing ideas, but in themselves elucidatory and suggestive. The Germans, too, have been most important critics, a natural consequence of their close attention to details; and Koch's criticisms of Pasteur's work may be perused with the greatest advantage by all who are interested in the subject, or are practically engaged in medical or surgical work. Some regret may be felt at a certain want of respect for the great Frenchman which seems to pervade the illustrious German's remarks. The true lover of science is little impressed, however, by the temporary acrimony of rival investigators, but is thankful for their mutual watchfulness. Pasteur remains the central figure in connection with the modern development of the germ theory; the discoveries and criticisms of the greatest of his contemporaries in the same sphere of investigation are, after all, of the nature of side-lights upon his work.

5. This is not the place in which to offer any opinion on theistic questions. But it is strictly within the scope of a scientific paper to recognise facts having a direct bearing upon the subject under consideration. It is a fact that Pasteur must be added to the list of "spiritualist" *grands initiateurs* enumerated by Naville. We may take cognisance of Pasteur's religious beliefs as resulting in an attitude of mind and a selective influence which have undoubtedly been the primary conditions of his peculiar success. Perhaps the most general expression of the scientific consequence of his beliefs will be to say that they have made of him in even an unusually strict sense an inductive rather than a deductive inquirer. He has approached natural phenomena, in the most absolute sense of the words, with the simplicity and teachableness of a pupil. When the French Ministry of Agriculture commissioned him in 1865 to study the diseases of the silk-worm, Pasteur, as he declares in the preface to his "Etudes sur la Maladie des Vers à Soie," had never even seen a silkworm. He mentioned this fact as a reason for declining the commission. "It is all the better" said Dumas, "that you know nothing about the subject; you will have no ideas upon it except those which result from your own observations." The determining mental conditions in Pasteur's work have been, firstly, a profound sense of the gulf between organic and inorganic matter, and, secondly, what may be most accurately described as a Christian sense of duty to his neighbours. The first was expressed in discovery of what he calls molecular dissymmetry, resulting in his formulation of the law that while all inorganic compounds can be superposed, all organic compounds are characterised by what he has graphically symbolised as right and left-handedness. Starting from this basis, the same fundamental principle guided him into a strong opposition of the doctrine of spontaneous generation, and into the famous researches on fermentation which have afforded the sure foundation of the modern developments of the germ theory, of the study of the etiology and rational treatment of zymotic diseases, of antiseptic surgery, and of sanitary science in general. Nor is the second principle less deserving of recognition as a cause of Pasteur's science. Dumas's description of the misery resulting to the rural population of France from the silk-worm disease induced him to undertake those researches on *pébrine and flacherie* which resulted in further important confirmations and elucidations of the germ theory; his researches on the "maladies" of beer were undertaken with the avowed hope that the impoverishment of France, consequent on the war of 1870, might be alleviated by the establisment of a great national brewing industry, rivalling that of Germany; in the interests of the ruined stock farmers of France, and with the same patriotic motive, he turned his attention to fowl cholera and anthrax; and not less have his later researches on every zymotic disease on which he has been able to lay his hands, and on hydrophobia, been inspired by a philanthropic desire to minister to the happiness of mankind.

6. In studying the work of one of the greatest and most successful investigators of this century, it is of scientific importance to recognise all the conditions which have contributed to the attainment of such remarkable results; and the facts noted in the last paragraph really force themselves upon the attention of the student of Pasteur's writings. It is the more desirable that attention should be given to these facts because erroneous impressions concerning Pasteur may retard the progress of science by weakening the influence of his utterances, and the confidence which they merit. There is a danger that the animated scenes in the French Académie des Sciences which have occasionally been reported, the tone of some of Koch's criticisms, the charges of dogmatism which have been levelled against Pasteur, and still more the misleading statements of those whose judgments are weakened by a more or less morbid and ignorant sentimentality respecting the lower animals, may give rise to misconceptions of the character of Pasteur. It is worth while, therefore, to say that no reader of Pasteur's own works can rise from their perusal without a strong consciousness that Pasteur is, in an exceptional degree, a single-minded and earnest man.

7. The foregoing brief *résumé* of the course of Pasteur's investigations indicates the inquiries into which the accumulated mass of work done in connection with the development of the germ theory now resolves itself. Starting with Leeuwenhoek's discovery of micro-organisms, Cagniard la Tour and Schwann's discovery that the globules of yeast are living plants capable of indefinite multiplication in suitable media, and Pasteur's demonstration that fermentation in general is necessarily associated with the presence of living organisms, we have opened up a series of most profound inquiries into the relations between chemical force and affinities in general and that undefined something which may be provisionally called vital force. From speculations as to the influence of vital force on the chemistry of nature in general, concerning which vastly wider views are now presented than were dreamt of in the pre-Pasteurian period, we naturally pass to inquiries as to the influence of chemical conditions upon the special forms and the special attributes of particular forms of organised life. From such inquiries we proceed to inquiries as to the origin and nature of microbes themselves, and the phenomena of their pathological relations.

8. With the overthrow of Liebig's motion or contact theory of fermentation, and the substitution of Pasteur's demonstrations that fermentation is a vital process, our view of the influence of the unknown force, vitality, in the chemistry of nature, has become so vastly extended that it may almost be said that chemical changes are dependent upon life. Death itself is life. The tendency is to the conclusion that no other forms of force could exert a sustained influence in rearranging the elements of matter. The changes possible in consequence of mere thermal or electrical conditions are so strictly limited that it may be said that without vitality certain forms and combinations of matter must have been eternal. Chemical affinity alone must have resulted in absolute stability. We may conceive the possibility of heat from an external source breaking up any matter, even living

matter; but it is the tendency of Pasteur's work to show that without such external action and without life a few given forms must have remained for ever unchanged. We have long been familiar with the notion that life alone can build up organic combinations. The vegetable takes up the inorganic element and elaborates it into food for the more complex tissues of the animal; Pasteur's teaching brings us to the conclusion that for the reverse process life is still necessary. Without the action of micro-organisms, dead organic matter would accumulate and be at least as permanent as the rocks. Pasteur's researches tend to banish from the universe such a process as purely chemical decay. It is the function of anærobies to split up organic tissues into simpler combinations, and we are indebted to the ærobies for the resolution of these simpler combinations into inorganic forms. It seems almost as though chemical affinity acted under the direction and control of life, and the fact that man in the laboratory is able to produce artificial compounds can scarcely be regarded as an exception to this rule. The opinions based on Pasteur's suggestion in 1862, that the production of nitrates in the soil is the work of a living organism, have been much strengthened and extended by such papers as that by Mr. R. Warington, on the value of microbes to the agriculturist, read at the meeting of the British Association at Southport, last year. Not less remarkable is Dr. Angus Smith's discovery of the giving off hydrogen from water as a consequence of the presence of microbes, and as constituting even a test of their activity. A brief *résumé* of Dr. Smith's observations on this point appeared in the *Manchester Guardian* of January 28th. Dr. Smith's own account, which will form part of his forthcoming Report as Inspector under the Rivers Pollution Commission, will be looked forward to with the greatest interest, and all will anticipate with keen expectation Dr. Smith's further researches based on a discovery which seems so full of suggestiveness. Dr. Smith found that from very pure spring water up to the most foul sewage hydrogen is given off, and that in each case its quantity is strictly proportionate to the activity of the microbe life present. Nitrates are found in rain-water, but have been attributed by Obin and Muntz to electrical action, and to the presence of minute crystals in the atmosphere.* Considered from Pasteur's standpoint it will be seen that such phenomena may vastly extend our idea of the part played by life throughout the universe. The philosophical result of Pasteur's teaching may be perhaps best expressed by his answer to the famous question of Liebig, repeated by M. Bouillaud in the Academy of Sciences, as to what are the ferments of ferments? "If," says Liebig, "the fungus or mushroom be the *cause* of the destruction of the oak —if the animalcule be the *cause* of the putrefaction of a dead elephant,—what, then, is the cause of the putrefaction after death of the fungus? what is the cause of the putrefaction and decay of the dead animalcule? They also ferment, decay, and putrefy, and finally disappear entirely, just as do the mighty tree and the gigantic animal; and the final products are the same in all." "Dead ærobies," replies M. Pasteur, "become the prey of new ærobies of different species or of their own species. Though a mass of germs becomes in its turn a mass of organic matter susceptible to putrefaction and combustion, those germs, nevertheless, represent life in its eternal form; for life is the germ, and the germ is life."

9. A consideration of the new views as to the influence of the microbe in the chemistry of the universe naturally leads to a consideration of the possible influence of chemical conditions upon the microbe. This is the old question of the influence of the environment upon the form of the organism, or, as we may say, in perhaps a deeper philosophical sense, upon its life. This branch of the enquiry has an important bearing upon the pathological problems involved. One of the things which most strike the student of Pasteur's work and that of his followers is the remarkable variety of conditions under which microbe life is apparently carried on. Here, again, it seems as though life was the dominant force in the universe which moulded almost any conceivable conditions to its use. "You have discovered," said Dumas to Pasteur, "a third order of beings in animated nature—creatures who can live either with or without free oxygen." Following up the experiments of Pasteur demonstrating the existence of life outside the conditions which mankind had come to regard as essential to life, and resulting in his classification of germs as anærobies and ærobies, we have had a most astonishing series of observations. Semper has called attention to the fact that far higher forms of life than we assume the micro-organisms to be actually do live under gaseous conditions which would be fatal to the higher Vertebrata, and that the capability of breathing assumed poisonous gases varies greatly in different animals. The mere inference by Pasteur that each form of fermentation has its peculiar ferment implies the existence of life under a most extraordinary variety of chemical conditions. Dr. Miquel has cultivated a bacterium which has the singular power of transforming sulphur into sulphuretted hydrogen, and which apparently lives and prospers in a *milieu* charged with sulphuretted hydrogen gas. The same experimentalist is sure of at least one bacillus which lives and multiplies in solutions heated to a temperrture of from 70° to 72° C., or 15° above the temperature assigned by Cohn as the limit beyond which, though spores may retain latent the power of germinating, no actual growth or multiplication by scissiparity or spore production can take place. Van Tieghem professes to have carried the limit within which vegetation is possible up to 74° C. We have further the experiments of the lamented Frank Hatton on the cultivation of bacteria in the presence of various gases supposed to be inimical to life, showing that bacteria can live and thrive in the presence of carbonic oxide, cyanogen, sulphurous anhydride, nitrogen, nitrous oxide, carbonic anhydride, and coal gas. Bacteria were also cultivated by the same inquirer in solutions containing large quantities of salicylic acid, strychnine, morphine, narcotine, and brucine. In all these cases the presence of the bacteria affected in a greater or less degree the chemical results; the decomposition of cyanogen, for instance, was "assisted" by the bacteria.

10. In all these cases it is far from unreasonable to assume that the particular media acted upon may have, in their turns, an influence upon the germs themselves. And although with that strong tendency to see things simply as they are and to avoid generalising, which is, in a peculiar degree, the quality of Pasteur, the author of the modern theory of fermentation has refused to recognise the hypothesis of Von Nägeli, Buchner, and of Dr. William Roberts, as to the convertibility of the different species of micro-organisms, he does not expressly deny its possibility, and has, indeed, together with his immediate disciples, demonstrated by many suggestive and remarkable experiments the existence of a certain amount of variability, or adaptability, in microbes. But provisionally, at least, Pasteur rests upon the recognition of a special ferment for each particular kind of fermentation, and what is, in his view, another way of saying the same thing, a special microbe for each zymotic disease; and the variability which he admits is simply a variability of vigour. With him, moreover, vigour and youth appear to be convertible terms, and it is important in following the course of his researches to retain this idea. "Do I deny absolutely the polymorphism of *Mycoderma aceti?*" says Pasteur in his "Etudes sur la Bière"; "on the contrary, I have endeavoured many times to establish it. I have sought chiefly for physiological polymorphism; that is, whether *Mycoderma aceti* was not, for instance, the ærobic mucor of a ferment differing from it physiologically, say of the lactic ferment, whose analogies of form with the *Mycoderma aceti* are sometimes striking. I have not

* If any reliance can be placed on spectrum analysis, alcohol is present in the tails of comets.

found anything hitherto. What I deny, with reference to this *Mycoderma*, are the polymorphisms admitted by M. Béchamp and other authors, which, in my judgment, rest upon erroneous and incomplete observations." Dr. Miquel, whose remarkable book on "Les Organismes Vivants de l'Atmosphère," containing the record of his experiments at the Montsouris Observatory, is full of interest, gives his testimony on the same side. "The theory of the evolution of species," he says, "can derive little profit from this class of experiments if they are conducted with the necessary rigour." After an enormous number of experiments he has found that the different species of microbes maintain their habits and their individuality unchanged for months and years. "Of 80,000 experiments," adds Dr. Miquel elsewhere, "not one has contradicted the affirmations of M. Pasteur, while many are in complete opposition to the statements published by some of his too zealous or inexperienced followers." Klein, as well as Koch, has also been forced to the conclusion that no satisfactory proof of the truth of Non Nägeli's fascinating hypothesis of the "sporting" of saprophytes, or, in other words, of the conversion of pathogenic bacteria into harmless saprophytes, and the reduction of the latter into the former, has yet been adduced, and he has published a series of experiments tending to show that Buchner was mistaken in supposing that he had established the convertibility of *Bacillus subtilis* and *Bacillus anthracis*, and offering an explanation of the phenomena on which Buchner's conclusion was based.

11. Nevertheless it must be admitted that the successive outbreaks and disappearances of epidemics, and the observations of Pasteur and others on the adaptability of microbes to different environments, and on the attenuation and cultivation of their vigour as ferments, cause Von Nägeli's hypothesis to have an inherent probability. Not that the idea that there is a struggle for existence between rival microbes, enunciated by Pasteur in his "Etudes sur la Bière," assumed by Klein to be the explanation of Buchner's supposed evolution of the anthrax bacillus from the hay bacillus (both forms being supposed to have inadvertently obtained admission to Buchner's culture solutions), and referred to by Miquel as the explanation of the varying proportions of germs in his cultures, may not also explain the occurrence of epidemics. If we assume the absolute inconvertibility of all species of microbes, epidemics might still be explained as the consequence of the occurrence of temporary conditions more favourable to the development of noxious than of harmless species. But this would really force us logically to the conclusion that all zymotic diseases have specifically existed as long as life itself. On the other hand we must be careful to distinguish between variability of species and what Pasteur means by variability of vigour. Pasteur's idea is perhaps most clearly conveyed by the use of the terms young and old germs, or we may perhaps better grasp the idea by using the terms tame and savage germs. Thus, let us take the remarkable observation of Pasteur concerning the difference in the proportion of fermentation accomplished in brewing, to weight of organism, in the presence or absence of free oxygen. In shallow vessels in which the ferment easily obtains free oxygen, 1 kilogrm. of ferment will correspond to 5 or 6 kilogrms. only of decomposed sugar; while in deep vats, in which the free oxygen is speedily exhausted, and the access of fresh supplies is prevented by the layer of carbonic acid formed above the vats, a kilogrm. of ferment corresponds to 70, 80, 100, and even 150 kilogrms. of sugar decomposed. It is as though the ferment in the presence of free oxygen lived the quiet and easy life of civilization, brought up a large family, and destroyed or consumed no more than was necessary for the support of the community; while the ferment thrust into the recesses of the vat and forced to tear oxygen from the material around him, figuratively speaking, cuts down a tree in order to cook a dinner, and destroys a forest in order to obtain a little breathing space. As the savage may acquire strength and ferocity by his mode of life, so it may be inferred that the germ actually acquires virulence by exercise in its anærobic mode of life. The question is, does this virulence become fixed by heredity, in any case, in such away as to amount to the establishment of a new species, with peculiar attributes which will enable it, not only to tear oxygen as a saprophyte from dead organic matter, but as a parasite from living tissues. For it must be borne in mind that, so far as reliable experiment has yet gone, the process absolutely stops at this point. The transformation of the harmless saprophyte into the deadly animal disease has not yet been conclusively shown.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

RHODIUM.

Berzelius† determined the atomic weight of this metal by the analysis of sodium and potassium rhodiochlorides, Na_3RhCl_6, and K_2RhCl_5. The latter salt was dried by heating in chlorine. The compounds were analysed by reduction in hydrogen, after the usual manner. Reduced to percentages the analyses come out as follows:—

In Na_3RhCl_6.

Rh.	3NaCl.	Cl_3.
26·959	45·853	27·189
27·229	45·301	27·470
		27·616
Mean 27·094	45·577	
		27·425

In K_2RhCl_5.

Rh.	2KCl.	Cl_3.
28·989	41·450	29·561

From the analyses of the sodium salt we get the following values for Rh:—

From per cent of metal	.. .. ..	Rh = 104·507
,, ,, NaCl	.. .. ..	,, 102·980
,, ,, Cl_3	.. .. ..	,, 105·696
,, ratio between Cl_3 and Rh	..	,, 104·829
,, ,, NaCl	,, ..	,, 104·093

These are discordant figures, and indicate some doubt as to purity of material. The last value is fairly good, however, and is confirmed by results from the potassium compound:—

From per cent of metal	.. .. ..	Rh = 104·054
,, ,, KCl	.. .. ..	,, 104·046
,, ,, Cl_3	.. .. ..	,, 104·065
,, Rh : Cl_3 ratio	.. .. ..	,, 104·057
,, Rh : KCl ratio	.. .. ..	,, 104·051
Mean	.. ..	,, 104·055

If O = 16, this becomes Rh = 104·285.

RUTHENIUM.

The atomic weight of this metal has been determined only by Claus.‡ Although he employed several methods, the only results worthy of present notice come from the analysis of potassium rutheniochloride, K_2RuCl_5. The

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Poggend. Annal.*, 13, 435. 1828.

‡ *Journ. f. Prakt. Chem.*, 34, 435. 1845

salt was dried by heating to 200° in chlorine gas, but even then retained a trace of water. The percentage results of analysis are as follows :—

Ru.	2KCl.	Cl_3.
28·96	40·80	30·24
28·48	41·39	30·22
28·91	41·08	30·04
Mean 28·78	41·09	30·17

Reckoning directly from the percentages we get the following discordant values for Ru :—

From percentage of metal	Ru = 103·016
,, ,, KCl	,, 107·190
,, ,, Cl_3	,, 96·854

Obviously, the best result is to be obtained from the ratio between Ru and 2KCl. This gives Ru = 104·217; or, if O = 16, Ru = 104·457. But little weight can be attached to this determination.

THE INFLUENCE OF ORGANIC MATTER AND IRON ON THE VOLUMETRIC DETERMINATION OF MANGANESE.*

By J. B. MACKINTOSH, New York City.

THE present note is intended as an addition to my previous communication on the volumetric determination of manganese, read at the Roanoke meeting,† it having been suggested‡ that the circumstances under which my experiments had been conducted were essentially different from those met with in the analysis of irons. The method used in these experiments is the same in all its details as that described in the paper referred to.

I have made seven experiments in all: two of these were in duplicate on half a gramme of a sample of spiegel dissolved in hydrochloric acid; one was on the same amount of spiegel with the addition of 25 c.c. of a standard solution of potassium permanganate; one was on the same amount of spiegel with the addition of 35 c.c. permanganate and much organic matter, viz., one drop of castor oil, two or three drops of coal-tar benzol and of gasolene (petroleum), about ten of alcohol, portions of starch and of sugar about the size of a small pea, and about half an inch of a common match cut into shavings. This organic matter was added to the manganese solution after the hydrochloric acid had been replaced by nitric, and the solution was heated until the wood shavings had disappeared. The fifth experiment was made by dissolving half a grm. of spiegel alone in nitric acid; the sixth by dissolving half a grm. of spiegel in nitric acid with the addition af 25 c.c. potassium permanganate, some oxalic acid, half an inch of a match, one filter-paper 7 c.m. in diameter, and two drops each of castor oil and turpentine; and the seventh experiment by dissolving half a grm. of spiegel in hydrochloric acid, and adding 35 c.c. permanganate, without, however, taking the precaution to evaporate off all the excess of hydrochloric acid.

Under these circumstances one would expect that if organic matter exercises any influence on the determination it would be plainly evident in the results obtained. But the accompanying table of results shows that there is no such evidence, the slight differences obtained being easily accounted for as errors of manipulation.

Experiment 3 shows that iron and the carbonaceous matter present in spiegel have no practical effect; experiments 4 and 6 show that extraneous organic matter has no effect; while experiment 7 shows that hydrochloric acid tends to make the results decidedly low. This is what we should expect, for the energetic oxidising action of the nitric acid and potassium chlorate employed, is very apt to destroy all organic matter present, while we know that MnO_2 is decomposed by hydrochloric acid. Another cause of the slight lowness of the results is the formation of permanganate. Frequently the wash-water is tinted slightly pink.

It may be well to call attention to the fact that the differences between the observed and calculated values in Nos. 3, 4, and 6 correspond to errors of 0·43, 0·92, and 0·22 per cent of the total amount of manganese present, including that in the spiegel, or to errors of 0·05, 0·12, and 0·025 per cent, if working on 1 grm. of spiegel or ferromanganese, on the total amount of all the constituents present.

The low results obtained by some chemists may perhaps be explained on the supposition that the potasssium chlorate used may be contaminated with potassium chloride, thus giving rise to the formation of free hydrochloric acid, which we see interferes with the accuracy of the process.

No.	Spiegel used, grm.	$K_2Mn_2O_8$ used, c.c.	Other constituents present.	Oxidising Power in terms of $K_2Mn_2O_8$. C.c.	Deduct for Mn in Spiegel. C.c.	Oxidising Power of Precipitate from $K_2Mn_2O_8$ added, C.c.	Theoretical for MnO_2. C.c.	Percentage of Theoretical
1	0·5	—	—	13·15	—	—	—	—
2	0·5	—	—	13·15	—	—	—	—
3	0·5	25	—	23·05	13·15	9·90	10·0	99
4	0·5	35	org. matter	26·90	13·15	13·75	14·0	98·2
5	0·5	—	—	13·15	—	—	—	—
6	0·5	25	org. matter	23·10	13·15	9·95	10·0	99·5
7	0·5	35	HCl	26·55	13·15	13·40	14·0	95·7

* A Paper read at the Chicago Meeting of the American Institute of Mining Engineers, May, 1884.

† *Transactions of the American Institute of Mining Engineers*, vol. xii., p. 79; and CHEMICAL NEWS, vol. xxxviii., p. 176.

‡ CHEMICAL NEWS, vol. xxxviii., p. 273.

ON DIOXYETHYL-METHYLEN, AND THE PREPARATION OF METHYLEN CHLORIDE.*

By WILLIAM H. GREENE.

WITH the exception of the diethyl-ether of methylen glycol, all of the oxy-ethyl substitution compounds of methan have already been described. Ortho-formic ether, $CH(OC_2H_5)_3$, was studied by Kay and Williamson, and is generally known as Kay's ether; ortho-carbonic ether, $C(OC_2H_5)_4$, was discovered and described by H. Bassett; methyl-ethyl oxide has long been known.

By a reaction similar to that by which these ethers are formed I have isolated dioxy-ethyl-methylen, the reaction between sodium ethylate and methylen chloride taking place as indicated by theory.

The chief difficulty lies in the preparation of pure methylen chloride. The process described by Perkin, and depending upon the reduction of chloroform by zinc and ammonia, yields only small quantities of methylen chloride, and the direct chlorination of methyl chloride yields equally unsatisfactory results. The method which, after

* Read before the American Philosophical Society.

numerous experiments, I have found to answer best consists in the reduction of an alcoholic solution of chloroform by zinc and hydrochloric acid.

The zinc and chloroform, mixed with several times its volume of alcohol, are placed in a flask connected with a suitable condensing apparatus, and hydrochloric acid is added in small portions. The reaction develops considerable heat, and methylen chloride and chloroform distil over. When the reaction has somewhat subsided, and no more liquid distils, more hydrochloric acid is added, and a moderate heat is applied if necessary. In any case the mixture is heated towards the close of the operation, until alcohol begins to distil in quantity. The operation is then arrested, and the product in the receiver is washed, dried, and rectified, that portion which passes below about 53° being retained. The residue is returned to the flask, and again submitted to the action of the zinc and hydrochloric acid. By several careful rectifications of the product passing below 53° pure methylen chloride boiling at 40° to 41° is obtained.

By several operations in this manner the yield of methylen chloride may be brought up to about 20 per cent of the chloroform employed.

Little or no advantage is gained by attempting to fractionate the product as it distils from the flask, so that the chloroform may flow back into the reducing mixture, for such distillation necessarily takes place in a stream of hydrogen, which carries with it about as much chloroform as methylen chloride.

Dioxy-ethyl-methylen.—This compound was prepared by gradually introducing one molecule of sodium into a mixture of one molecule of methylen chloride and about four times the theoretical quantity of absolute alcohol, contained in a flask connected with a reflux condenser. After all of the sodium has been introduced the mixture is heated on a water-bath for about an hour, and is then distilled. The distillate is fractionated, and the portion which passes below 78° contains all the diethyl ether. It is agitated with a tolerably concentrated solution of calcium chloride, and the light ethereal layer is separated, dried over calcium chloride, and carefully rectified, until a liquid is obtained which boils at 86° to 89°.

Dioxy-ethyl-methylen so obtained is an ethereal liquid, having a penetrating pleasant odour, somewhat recalling that of mint. Its specific gravity at 0° is 0·851, and it boils at 89°, under a pressure of 769 millimetres. It is slightly soluble in water, from which it may be separated by the addition of calcium chloride: it mixes in all proportions with ether and alcohol, and it cannot readily be separated from its alcoholic solution if much alcohol be present. In such a case, fractional distillation and treatment of the portion which passes below 78° with solution of calcium chloride effect the separation.

ON A NEW SYNTHESIS OF SALIGENIN.*

By WILLIAM H. GREENE.

THE method by which I have obtained saligenin synthetically is an application of a general method for the preparation of phenolic derivatives, made known by Reimer and Tiemann. Indeed, since by the reaction of chloroform or of carbon tetrachloride on an alkaline solution of sodium phenate salicylic aldehyd or salicylic acid may be obtained, it may naturally be expected that, under the same circumstances, methylen chloride would yield saligenin, the latter being an oxy-benzylic alcohol.

A mixture of 30 grms. of methylen chloride, 30 grms. of phenol, and 40 grms. of sodium hydrate dissolved in 50 grms. of water, was heated in a sealed matrass in a water-bath. The reaction is complete in about six hours, after which the contents of the matrass is neutralised with hydrochloric acid, and agitated with ether, which takes up the saligenin and the excess of phenol. The ethereal solution is decanted, and the ether distilled off; the residue is repeatedly exhausted with boiling water, which takes up the saligenin and leaves the greater part of the phenol undissolved. The aqueous solution is concentrated to a small volume, and the drops of phenol which separate on cooling are removed. After exposing the residue for some time over sulphuric acid, a crystalline mass is obtained, which is pressed, and re-crystallised from boiling water or from alcohol. Pure saligenin is thus obtained.

The quantity of saligenin is by no means in proportion to the quantity of phenol employed, and an alcoholic solution of sodium hydrate was found to yield no better results than an aqueous solution, although the reaction took place more promptly.

Isomeric oxy-benzylic alcohols may be, and probably are, formed at the same time, but I have not yet been able to isolate such compounds.

* Read before the American Philosophical Society.

THE QUALITATIVE DETECTION AND THE QUANTITATIVE DETERMINATION OF ARSENIC, SULPHUR, AND PHOSPHORUS, AND OF CERTAIN METALS PRESENT IN MINUTE QUANTITIES IN COMMERCIAL COPPER.

By O. KUHN.

THERE was published in the *Zeitschrift fur Analytische Chemie* (vol. xxi., p. 516) a memoir under the above title by Dr. Jul. Löwe, upon which I submit certain remarks.

The author states:—"In presence of sulphur (or of one of its oxides) along with lead in copper a part of the precipitate insoluble in nitric acid will consist of lead sulphate." This, however, can happen only when a considerable quantity both of lead and sulphur occurs in the copper in question. Even then only a part of the lead sulphate formed is precipitated, whilst the rest remains in solution, and is only thrown down on the addition of alcohol. Most of the refined coppers of commerce, which really contain lead, give no precipitate on the direct addition of sulphuric acid until alcohol is also added.

The same remark applies to the method laid down for precipitating the main quantity of the lead, in which likewise an addition of alcohol, and the washing of the precipitate with water containing alcohol and sulphuric acid, is necessary.

The separation of the arsenic by precipitating the solution of the copper (first rendered ammoniacal) with magnesia mixture gives too low results, and if the quantity of arsenic is trifling no precipitation at all takes place, so that the presence of arsenic may be entirely overlooked. In order to retain 15 to 18 grms. copper in ammoniacal solution a considerable quantity of water must be added, and in the volume of liquid thus formed (at least 1½ litre) a notable quantity of ammonium-magnesium arseniate remains in solution. An addition of alcohol lessens this evil, but does not remove it entirely.

The separation of the phosphorus from the ammoniacal solution of copper suffers from the same defect, though to a far less extent, since ammonium-magnesium phosphate is far less soluble in ammoniacal water than is the corresponding arsenical compound.

The separation of copper from zinc, nickel, and cobalt suffers from the same evil, which the author himself points out as regards the separation of arsenic with potassium sulphide. When 15 to 18 grms. copper are used—and this is scarcely to be avoided in view of the minute proportion of the foreign metals in question—the precipitate of copper sulphide produced by the introduction of sulphuretted hydrogen is very bulky, and cannot easily be thoroughly washed, remembering how readily copper sulphide becomes oxidised.

With reference to the above-mentioned sources of error I venture to propose a method which I have used for some time, and which on several grounds seems to me preferable to the method of Dr. Löwe.

For the determination of the proportion of copper a small quantity of the sample (0·5 to 0·8 grm.) is dissolved in nitric acid, and titrated with potassium sulphocyanide, according to Volhard's well-known method. The determination of silver, lead, and bismuth (iron and manganese) is effected in a separate portion of the sample, and that of arsenic, phosphorus, sulphur, zinc, nickel, cobalt, iron, and manganese in a third portion, both the two latter of from 15 to 18 grms.

The two latter portions are dissolved, each separately, in nitric acid, evaporated to dryness, to render tin oxide insoluble if present, and the residue is dissolved in water, with the addition of a quantity of nitric acid just sufficient. If a residue is left it is filtered off, washed with hot water, and tested by known methods for antimony, tin, silicon, phosphorus, arsenic, and lead sulphate, the last only, as above mentioned, when considerable quantities of lead and sulphur are present. It must be remembered that when the copper contains iron along with tin the tin oxide always appears coloured yellow by iron oxide, from which it cannot be separated by boiling with acids. It is therefore necessary to separate them by fusion with sodium carbonate and sulphur.

The solution of one portion of 15 to 18 grms. copper is mixed with hydrochloric acid for the separation of silver. To the filtrate are added sulphuric acid and alcohol to throw down lead sulphate, which is filtered off and washed with water containing sulphuric acid and alcohol. Up to this stage of the process care must be taken that a sufficiency of acid is always present in the solution to prevent a separation of bismuth, if present, by the washing-water.

The filtrate from the lead sulphate is supersaturated with ammonia according to Löwe's method, when bismuth and iron oxides are eliminated and separated by known methods. If, however, the copper contains along with iron relatively considerable quantities of phosphorus or arsenic the precipitation of iron oxide is always imperfect. Both precipitate and solution contain ferric oxide and phosphoric or arsenic acid. This is at once perceived on adding to the filtrate magnesia mixture. The precipitate of ammonium-magnesium phosphate (or arseniate) is coloured more or less deeply yellow by a simultaneously deposited ferric oxide. If iron and phosphorus are both present we obtain them in two separate precipitates, on which account it is preferable to determine the iron in the second portion of 15 to 18 grms. copper.

In the solution of this second portion the sulphuric acid is first precipitated by means of barium nitrate; the filtrate is evaporated to dryness with such a quantity of sulphuric acid that all the metallic oxides may be combined with this acid.

The residue from evaporation is dissolved in water, mixed with just enough sodium carbonate to cause a permanent precipitate, heated almost to boiling along with sulphurous acid, and all the copper is thrown down as a sulphocyanide by means of the smallest possible excess of potassium sulphocyanide. When quite cold the liquid and the entire precipitate are rinsed into a 500 c.c. flask, filled up to the mark with water, and well shaken after so much more water has been added as corresponds to the volume of the precipitated copper sulphocyanide. This compound, when recently precipitated, has the sp. gr. 3·16, whence the volume of the precipitate may be readily calculated (10 grms. copper give 19·16 copper sulphocyanide,

$$= \frac{19{\cdot}16}{3{\cdot}16} = 6{\cdot}06 \text{ c.c.})$$

From the contents of the flask 400 c.c. are filtered through a dry folded filter, and concentrated to a small volume. It is then heated with nitric acid added drop by drop till all excess of potassium sulphocyanide is decomposed, and the resulting hydrocyanic acid is expelled. The liquid thus concentrated is boiled with sulphurous acid, the latter driven off, and sulphuretted hydrogen is passed into the hot liquid until the arsenic present is entirely thrown down. The arsenic in the iron arsenide thus obtained is determined by one of the known methods.

From the liquid thus freed from arsenic, the iron, nickel, cobalt, zinc, and manganese are precipitated as sulphides by the addition of ammonia and ammonium sulphide, and are separated and determined by the ordinary methods. The ammonium sulphide in the filtrate is decomposed by hydrochloric acid, and phosphorus is precipitated by ammonia and magnesia mixture as ammonium-magnesium phosphate. On account of the large quantity of potassium salts in the solution the precipitate always retains potassa and must be redissolved in a little hydrochloric acid and again thrown down by ammonia and a few drops of magnesia-mixture.—*Zeitschrift fur Analyt. Chemie.*

VERMILLION—ITS MANUFACTURE IN CHINA.

The Chinaman has no knowledge whatever of chemistry, and of the principles of natural philosophy and statics generally his notions are of the most rudimentary and primitive description. How, then, in the face of these obvious disadvantages have the Chinese contrived to place themselves in the front rank amongst nations in the matter of certain chemical manufactures, one of the most important of which is the subject of this article,—Vermillion? In our last article we have seen with what ingenuity and pertinacity in carrying out his ends the Chinaman has succeeded in making perhaps the most delicate and perfect iron castings in the world. He has succeeded in that instance not by any deep researches into the hidden mysteries of Nature, by no process of thought involving an inquiry into the "reason why;" to this the Chinaman is averse, the whole tendency of his eduation, such as it is, tends to made him satisfied with observing effects; it is sufficient to him to know that things are so, without going into troublesome or elaborate investigations into those changeless laws of Nature into which his philosophy teaches him that, as he cannot alter or control research, is fruitless; but that he has in his own small, ingenious, patient way observed effects to very good purpose the unrivalled excellence of some of his manufactures testifies. We will now enter a vermillion manufactory and watch the process from the first stage of mixing its two ingredients—mercury and sulphur—to the final process of weighing and packing this costly and beautiful pigment for the market.

The first objects to attract the visitor's attention on entering the yard attached to the works will probably be large piles or stacks of charcoal, crates, or baskets of broken crockery ware, and numerous rusty old iron pans of somewhat similiar shape to the rice pans previously described, but considerably thicker and heavier. There will also probably be a few broken and disused cast-iron mortars. All these articles are the cast off or worn out implements of the manufacture, and will be described in their proper order. On entering the factory proper, scores of little stone mills, each being turned by one man, and other long rows of workmen weighing out and wrapping up the vermillion will be seen. The furnaces are then arrived at: these may be a score or more in number and may be ten or twelve in each furnace room, five or six on each side. After passing these the stores of quicksilver, sulphur, alum, glue, new spare iron pans, serviceable crockery ware, and sieves and other utensils used in the factory are arrived at, and this completes the view of the works. The iron pans in which the vermillion is sublimed are those referred to above; they are circular and semi-spherical in shape; all are of the same size and weight; they are cast upside down, and in the casting, a runner or lump of iron, two and three-eighths inches in diameter by from six-eighths to one inch in depth, is purposely left on

every pan in order to enable the workman the more readily to handle the pan when stirring up its contents. The size of the pans proved by actual measurement to be 29¼ inches in diameter, by eight and seven-eighths inches deep, and the weight 40 catties, or say about 53 pounds. These pans are set in rows of 5 or 6 on each side of a small rectangular room, in size some 12 ft. by 15 ft.; the door of this room is of wood and contains an aperture a few inches square in order to enable the workman to watch the progress of his operation, from time to time, without the necessity of lowering the temperature of the apartment by opening the door. The pans are set in brickwork, each pan having beneath it a grate to hold the charcoal used as fuel. There is no communication between the grates or furnaces under each pan, and no chimney, the flames and products of combustion finding exit from the front of the grate which is left wholly open at all stages of the operation.

The process of manufacture is as follows:—Taking an iron pan, which is of four inches smaller diameter than those described, and also in all other respects proportionally less, except the runner, which is of the same size, a skilled workman proceeds to weigh out 17½ lbs. of sulphur. This he places in the pan, and adds about half the contents of a bottle of quicksilver. The pan with its contents is then put upon a small earthen brazier or portable furnace, the fuel used in which is charcoal. When the sulphur is sufficiently melted, the workman, taking an iron spatula or stirrer, rapidly stirs up the quicksilver with the sulphur, and gradually adds the remaining contents of the bottle of quicksilver, stirring the two ingredients together meanwhile until the mercury has wholly disappeared, or "been killed," as the Chinese put it. When this takes place the pan is removed from the fire, a small quantity of water is added, and rapidly stirred up with the contents of the pan, which have now assumed a dark blood-red appearance and semi-crystalline structure. This mass is then turned out of the pan into an iron mortar, and then broken up into a coarse powder. This forms a charge for one of the large pans previously described, and when sufficient material has been prepared to charge all the pans in one furnace chamber the sublimation is proceeded with as follows:—All the pans having received their quantum of crude vermillion, this is covered with a number of crockery- or porcelain-ware plates of tough, strong manufacture, each about 8 inches in diameter; some of these plates, however, are broken up, and are in a more or less fragmentary condition. When these plates have been piled up into a dome-shaped heap of the same shape as the bottom of the upper pan, to which they should extend, the whole is covered with one of the smaller pans previously described. Now, it will be remembered that the smaller pan was of 4 inches less diameter than the larger one; there will consequently be a circular space of two inches all round between the circumference of each pan. Consequently the rim of the upper or covering pan will be about 2 inches lower than the rim of the lower pan; there will also be some 4 inches space horizontally between the rim of the large lower pan and that portion of the smaller pan which is at the same height as the rim of the larger one. This space is carefully filled with a clay luting into which some holes, generally about four in number, are pierced, extending down to the rim of the smaller pan or cover; this is done in order to allow the heated air and other matters to escape. All the pans in one furnace chamber being thus charged and covered the fires are lighted. The flames from the charcoal should occasionally play several feet above the mouths of the furnaces. The door of the chamber is kept closed, except when it is open for a moment in order to enable the workmen to replenish the fires, which must be kept up at a fierce heat for eighteen hours. During this process a blue lambent flame is seen to play above each of the four holes which are pierced through the clay luting of the pans, so it is evident that a considerable quantity of either one or probably both the ingredients is wasted. After eighteen hours the fires are allowed to go out, and the contents of the pan cool down. When this is accomplished the greater portion of the vermillion will be found adhering to the lower surface of the broken-up porcelain plates with which the crude product is covered. The vermillion is then carefully removed from the porcelain by means of chisels, and is now ready for the elutriating mills. Another portion of vermillion of not so good quality is found adhering to the upper iron pan and that obtained by washing the clay luting in a cradle, as diggers wash dirt for gold. This together with the wipings and scrapings generally is mixed up with alum and glue-water into cakes, and, after drying on a brick surface heated beneath by means of wood or charcoal, is powdered up on a mortar, and re-sublimed when a sufficient quantity has accumulated.

The vermillion which was removed from the porcelain plates is of a blood-red colour and crystalline structure. This is then powdered up in a mortar and removed to the levigating mills; these are the ordinary little horizontal stone mills used by Chinese and other natives of the East to grind rice and other grain into flour or pulp, as the case may be. Each stone is about 2½ feet in diameter; the lower stone is stationary, the upper is turned by a direct-acting piece of wood having a hole in it which works a wooden peg affixed to the upper stone, which is made to revolve by a backward and forward movement of the piece of wood, or handle, some 3 or 4 feet long, previously mentioned. One man turns each mill. The upper stone has a small hole in it near its centre, down which the workman from time to time pours a little spoonful of the powdered vermillion, which he washes down into the mill with water: as he turns the mill the workman keeps continually ladling little spoonfuls of water down the aperture or hole in the upper stone; the ground and thus elutriated vermillion, as it escapes from between the stones, is washed down by the water into a vessel placed beneath to receive it. When work is suspended for the evening the ground vermillion is carefully stirred up with a solution of glue and alum in water, in the proportion of about an ounce of each to the gallon. The glue has been made to mix with the water by previously heating it with a small quantity of water; the earthen pots in which this process is effected each hold about 6 gallons. The mixture is then left to settle. In the following morning the mixture of glue and alum is poured off the vermillion, and the upper portion of the cake of vermillion at the bottom of the vessel—that is, the portion which remained longest suspended in the liquid—will be found to be in a much finer state of subdivision than the lower portion, which requires to be again elutriated as on the previous day: this separation of the more finely divided vermillion from that which was coarser, by suspension in a dense medium, is a really most ingenious process, for which we should give the Chinaman every credit. The process of grinding, elutriation, and separation of the coarsely ground from the fine vermillion, sometimes requires to be several times repeated, in order to fully bring out the colour. As a final process the damp cake of finely ground vermillion is stirred up with clean water, and allowed to settle down until the next morning, when the water is carefully poured off into large wooden vats to still further deposit a small quantity of vermillion still remaining in suspension, and the vermillion dried in the open air on the roof of the premises. When quite dried the cakes of now full-coloured pigment are carefully powdered and sifted by means of square muslin-bottomed sieves, contained in a covered box some 2 feet high by 2½ wide, in which the sieves, which slide on a framework inside the box, are jerked backwards and forwards by means of a handle on the outside of the box or case containing them.

The now fully-prepared vermillion is removed to the packing house, where may be seen rows of workmen, men and boys, seated before a series of tables. Between every two workmen is a third, with a small pair of scales, which he holds in his left hand; and as the workmen on either side place before him the little pieces of paper in which

the vermillion is to be wrapped up, he weighs into each paper one tael (about an ounce and a third avoirdupois) weight of vermillion: the papers are two in number, the inner a black or prepared paper, and the outer a piece of ordinary white paper. After being wrapped up the packets are placed in rows before another workman, who stamps them with a seal containing in Chinese characters the name and address of the manufactory in which the article has been made, and the quantity and quality of vermillion contained in the packet.

The rapidity and deftness of the Chinese workmen at this employment is really surprising, the stamping, for instance, is effected at the average rate of sixty impressions per minute, and the wrapping up is carried on with proportionate rapidity. The mixture of alum, which is the ordinary aluminium potassium sulphate, with the vermillion, in one of its stages of manufacture as described above, is not added, as at first sight we thought it might be, merely to assist in clarifying or purifying the water by causing it to deposit its sediment, but seems to have some peculiar effect upon the colour. Although what may be the *rationale* of the process, or how it acts we cannot quite clearly see; the glue is added as described above merely to favour separation of the finely elutriated vermillion by holding it longer in suspension than the coarser particles, which sink first, and may therefore be separated in their order of stratification. The actual composition of vermillion is one hundred parts of mercury to sixteen of sulphur, when both these ingredients are in a perfectly pure state; the excess of five and one-third pounds of sulphur added by the Chinese is probably volatilised and lost in the process of sublimation, or as the sulphur used is generally not quite pure, a part may go for foreign matter contained in the sulphur; the balance being probably the *raison d'etre* of the blue lambent flame seen playing over the apertures in the luting during the sublimation process. For a people having like the Chinese no acquaintance with even the first rudiments of chemistry, the proportion of ingredients taken—56¼ catties to 13 catties, or say 75 pounds to 17 and one-third pounds—shows wondefully accurate powers of observation and a knowledge of combining proportions only to be gained by much experience and a long extended series of careful observations highly creditable to the manufacturers. The entire process is one of the most ingenious and interesting to be seen in any part of the world.

T. I. B.

Hongkong, March 29, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 1, July 7, 1884.

The Absorption of Chlorine by Carbon, and its Combination with Hydrogen.—MM. Berthelot and Guntz.—When purified wood-charcoal is saturated with gaseous chlorine, and then treated with hydrogen gas, hydrochloric acid is formed, with a fall of temperature. The authors explain this anomaly by the consideration that the absorption of heat results not from the chemical action, properly speaking, but from the simultaneous evaporation of the chlorine condensed upon the charcoal.

The Chemical Composition and the Alimentary Value of the various parts of the Grain of Wheat.—Aimé Girard.—The author regards the grain of wheat as consisting of three parts, the shell (which forms 14·36 per cent), the germ (1·43 per cent), and the farinaceous layer (84·21 per cent). The author considers that the introduction of the shell and the germ into flour is only of an insignificant utility, and is attended with serious inconvenience.

Electric Conductivity of Very Dilute Aqueous Solutions.—E. Bouty.—All the organic substances which the author has examined conduct very badly. Anhydrous alkalies and acids are not conductors; hydrated alkalies and acids conduct in the same manner as salts.

On Phosphoric Anhydride.—P. Hautefeuille and A. Perrey.—In this memoir the authors establish the existence of three phosphoric anhydrides, the first crystalline, the second amorphous and pulverulent, the third amorphous and vitreous, the two latter being polymers of the former. The phosphoric anhydride obtained by the ordinary method is not a homogeneous substance, but a mixture of the crystalline and of the amorphous pulverulent anhydrides. The crystalline anhydride is obtained by distilling the products of the complete combustion of phosphorus. The amorphous pulverulent anhydride is prepared by heating the crystalline form to 440°. The vitrous amorphous form is produced on heating either of the foregoing to incipient redness under a strong vapour-tension.

Certain New Boro-tungstates.—D. Klein.—The author has obtained disodium-tungsto-borate, and a corresponding barium salt, which, however, contains six more molecules of water.

Dehydrating Action of certain Salts.—D. Tommasi.—From the researches of M. Grimaux on the coagulation of colloidal bodies it would appear that salts promote the coagulation of colloidal bodies by acting as dehydrating agents. The author mentions that there are cases where certain salts produce an effect exactly opposite, and entirely hinder bodies from becoming dehydrated. Thus cupric hydrate, if heated in presence of water, is rapidly transformed into the black oxide at about 77°, but in presence of a trace of manganese sulphate it does not become dehydrated even on boiling.

Perseite, a Saccharine Matter analogous to Mannite.—A. Muntz and V. Marcano.—This compound, until recently confounded with mannite, occurs in the fruit of *Laurus persea*.

On Certain Derivatives of Meta-xylene.—A. Colson.—The compounds investigated by the author are meta-xylene bibromide, meta-xylenic glycol, and meta-xylene bichloride.

Polarimetric Researches on Cellulose Regenerated from the Pyroxyls, and on Cellulose submitted to the Action of Sulphuric Acid.—A. Lavallois.—The author's results show, contrary to the theory of M. Blondeau, that the substance recovered from the nitro-celluloses is identical with cellulose, or rather with hydrocellulose. Cellulose poured into an excess of alcohol after prolonged treatment with sulphuric acid gives a deviation of only 5·5°, that of the cellulose of paper being 10·5°.

Preparation of Farm-yard Manure.—P. P. Deherain.—The author finds that straw is oxidised in contact with the air only under the influence of a "figured" ferment. There may be distinguished in dung a neutral fermentation producing carbonic acid and formene, and an acid fermentation in which there are produced butyric acid, hydrogen, and formene.

No. 2, July 15, 1884.

Second Memoir on Flour.—M. Balland.—Among the author's conclusions are that the proportion of moisture contained in the various products of grinding is sensibly the same. There is a constant relation between the hygrometric state of the air and the degree of moisture of a flour. Flours generally contain from 1 to 2 per cent more moisture in winter than in summer. The mean of moisture in the flours of commerce is 14 per cent.

Electro-Conductivity of Distilled Water and of Ice.—The resistance of distilled water becomes 15,000 times

greater at the moment of congelation. The resistance of ice, however, undergoes variations corresponding to those of the water from which it is formed.

Purification of Methylic Alcohol.—MM. J. Regnauld and Villejean.—In the alcohol regenerated from methyl-oxalic ether the authors dissolve about 1-10th of its weight of iodine. To this liquid they add by degrees an aqueous solution of sodium hydroxide in sufficient quantity to produce complete decolouration and a decidedly alkaline reaction. If submitted to careful distillation this mixture gives methylic alcohol, not convertible into iodoform, and which, on rectification over quicklime, has the spec. gr. 0·8110 at 15°.

Deposit of Saltpetre near Cochabamba in Bolivia.—M. Sacc.—To the east of Cochabamba is an immense saline deposit consisting of potassium nitrate, 60·70; borax, and traces of salt and water, 30·70; organic matter, 8·60. If this mixture is dissolved in boiling water there is, on cooling, an abundant crystallisation of pure saltpetre.

No. 3, July 21, 1884.

Comparison between the Hypothesis of Currents around the Axis of a Magnet with that of Currents around each Molecule.—Augustin Fresnel.

Second Note on the Hypothesis of Particular Currents.—Augustin Fresnel.—These two memoirs have been discovered amongst the papers of Ampère. They do not admit of useful abridgment.

Electro-capillary Relations.—P. Garbe.—The electric capacity at the constant surface of an electfode plunged into a liquid is a function alone of the electric difference, independent of the sign of this difference, and it is at a minimum when this difference is null.

Direct Measurement of the Two Static Components and of the Dynamic Component of the Magnetic Field of Collector-Machines.—G. Cabanellas.—This paper does not admit of useful abridgment.

Researches on Magnetism.—M. Duter.—The author proves experimentally that the magnetism of flat steel magnets whose surfaces are their poles does not disappear when they are removed from the magnetic field.

New Battery with Electrodes of Coke.—MM. D. Tommasi and Radiguet.—Both electrodes consist of plates of coke; the one surrounded by a paste of lead peroxide, and the other covered on its horizontal upper surface with fragments of platinised coke. The two are separated by means of parchment paper. The exciting fluid is a saturated solution of sodium chloride.

Critical Temperature and Pressure of Nitrogen. Boiling-points of Nitrogen and Ethylen under Low Pressures.—K. Olszewski.—At a pressure of 9·8 m.m. the temperature of ethylen is −153·4°. At a pressure of 33·6 atmospheres and a temperature of −146° nitrogen boils and its meniscus is observed. The author maintains that his experiments do not confirm the solidification of nitrogen under the conditions indicated by M. Wroblewski.

Properties of Liquefied Marsh-Gas, and its Use as a Refrigerant.—S. Wroblewski.—By making use of the vapours of ethylen the author has reduced their pressure to 0·015 metre, and lowered the boiling-point to −144°. The boiling-point of liquefied marsh-gas is between −155° and −160°. Oxygen, air, nitrogen, and carbon monoxide may be liquefied at low pressures if cooled with this gas.

Action of the Induction-Spark upon Benzol, Toluol, and Aniline.—A. Destrem.—Benzol yields a mixture of 42 to 43 per cent acetylen, the residue being hydrogen. Toluol gives hydrogen, with 23 to 24 per cent of acetylen. Aniline yields 21 per cent of acetylen, 65 of hydrogen, hydrocyanic acid 9, and nitrogen 5.

Production of a Crystalline Barium Manganite.—G. Rousseau and A. Saglier.—The authors, by obtaining this compound, confirm the view of Gorgeu and Risler that manganese peroxide may be regarded as manganous acid. Artificial barium manganite forms small acicular crystals of a bluish black. It dissolves readily in hydrochloric acid, with liberation of chlorine. Its specific gravity is 5·85, whilst that of the native manganite (psilomelane) is only 3·7 to 4·4.

Compounds formed by Chromium Sesquichloride with other Metallic Chlorides.—L. Godefroy.—Chromium sesquichloride forms definite crystalline compounds with the other metallic chlorides. They are all formed when the two chlorides are mixed in presence of an excess of strong hydrochloric acid. An increase of temperature promotes their formation, but the presence of water prevents it. They are all decomposed by water. Double chromium bromides and iodides may be obtained in a similar manner.

On a General Reaction of the Polyatomic Alcohols in presence of Borax and the Para-tungstates.—D. Klein.—A solution containing less than 0·5 mol. of borax to 1 mol. of dulcite is strongly acid. A solution containing 0·5 mol. borax to 1 mol. dulcite is neutral, and a liquid containing more than 0·5 mol. of dulcite per mol. of borax is alkaline. A mixture of solutions of dulcite and sodium para-tungstate presents the same reactions as those of mannite with the same salt.

Origin and Distribution of Phosphorus in Coal and Cannel.—A. Carnot.—The author finds ponderable quantities of phosphorus in the fossil plants imbedded in coal.

Variation, with Pressure, of the Temperature at which the Transformation of Silver Iodide is produced.—MM. Mallard and Le Chatelier.—Silver iodide at 146° passes from a hexagonal to the cubic symmetry, but an increase of pressure lowers the temperature at which this change takes place.

———

Bulletin de la Société Chimique de Paris.
No. 11, June 5, 1884.

Isomeric Benzine Hexachloride.—Jean Meunier.—The ordinary hexachloride melts at 157° and crystallises in tables belonging the clinorhombic system. The isomer melts at 310°, subliming at once and crystallising in cubic octahedra,

Formation-Heat of Certain Soluble Compounds, and on the Law of Thermic Constants.—D. Tommasi.—The author gives the combination-heat of potassium and ammonium chromates as determined experimentally, and as calculated according to his law. He appends a table of the calculated combination-heats of the remaining soluble chromates and bichromates, the glycolates, sulphites, and fluorides. He shows, in opposition to M. Berthelot, that his law is applicable to the soluble salts of lead and mercury.

Pretended Association by Crystallisation of Bodies having no Analogy in their Atomic Constitution.—C. Marignac.—The author refutes the objections raised by Brügelmann to the doctrine of isomorphism as generally accepted. When a salt crystallises in a solution containing foreign salts in a notable proportion, the crystals formed cannot be perfectly pure; they always entangle a small quantity of these foreign salts whatever their nature. This mechanical occlusion of some traces of mother-liquor saturated with such salts has no connection with the regular association in proportions far larger, which takes place between salts of the same atomic constitution.

Russian Correspondence.—M. Lwoff announces that iso-butylen chloride cannot be obtained even when the action of chlorine upon iso-butylen takes place in direct sunlight.

M. Mihailoff communicated a new method of obtaining pure albumen. He filters white of egg through a cloth and adds a volume three times as large of a saturated

solution of ammonium sulphate, adding to the liquid obtained further quantities of the same salts until it no longer dissolves. All the albumenoid substances are then found in the precipitate. This precipitate is washed with a saturated solution of ammonium sulphate, and the concentrated solution of this precipitate (previously neutralised with ammonia until the reaction is slightly alkaline) is dialysed. The water precipitates all the globulines and globulinates, whilst pure albumen remains in solution. This solution does not coagulate if heated to boiling, has a reaction almost neutral (feebly acid), and does not precipitate salts of barium. The precipitation by ammonium sulphate is one of the most sensitive reactions of all the albumenoid matters and their derivatives.

M. Mihailoff discussed the application of Mohr's method to the determination of chlorine in urine.

M. Sokoloff gave the results of the analysis of the water of the Neva during November.

M. Alexeeff expounded his researches on the solutions of substances containing carbon in sulphur. The solubility of the homologues diminishes with the increase of the molecular weight.

M. Mendeleeff presented a paper on solutions. On calculating the pressure corresponding to the solution of the salt according to the contraction which accompanies the formation of the given solution, the author finds that to each mol. of sodium chloride dissolving in 100 parts of water there corresponds for all concentrations one and the same pressure = 120 atmospheres. For calcium chloride, the pressure is also constant and three times greater.

M. Lawroff announces that in the action of metallic glucinum upon mercury dimethyl at 130° in sealed tubes, we obtain a white, crystalline, volatile substance which ignites on contact with water.

M. Bagaroff sent in a memoir on affinity.

M. Kanonikoff communicated a second memoir on the relation existing between the specific refractive energy of chemical compounds and their composition.

M. Menschutkine gave an account of his researches on the formation of the amides on setting out from the ammoniacal salts.

The first part of vol. xvi., of the *Journal of the Russian Chemical Society*, contains the following memoirs:—

"On the Expansion of Liquids," by M. Mendeleeff, and "On the Vapour-tension of Solutions," by M. Konovaloff.

Researches on Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.

Influence of the Density of Gaseous Detonating Mixtures under Pressure: Isomeric Mixtures.—MM. Berthelot and Vieille.

The Specific Heat of Gaseous Elements at very High Temperatures.—MM. Berthelot and Vieille.

Specific Heats of Water and Carbonic Acid at very High Temperatures.—MM. Berthelot and Vieille.

On the Scale of Temperatures, and on Molecular Weights.—M. Berthelot.

Relative Speed of Combustion of Detonating Gaseous Mixtures.—MM. Berthelot and Vieille.

The Reciprocal Displacements between Hydrofluoric Acid and other Acids.—MM. Berthelot and Guntz.

Equilibria between Hydrochloric and Hydrofluoric Acids.—MM. Berthelot and Guntz.

These last eight papers are substantially reproductions of matter which has appeared in the *Comptes Rendus*.

No. 12, June 20, 1884.

Production of Coke and the Utilisation of the Secondary Products of its Manufacture.—M. Scheurer-Kestner.—A compilation chiefly derived from a paper read by Mr. Watson Smith at the Southport Meeting of the British Association and from an article in the *Journal of Chemical Industry*.

On Selenio-Urea.—M. A. Verneuil. — Selenio-urea, C_2N,H_4Se_2, is very soluble in hot water, but much less so in cold, which at 19° takes up only 10·70 per cent. Absolute alcohol at 18° dissolves 2·88 per cent, and ether at the same temperature only 0·56 per cent. If suddenly heated it melts without apparent decomposition, but if its temperature is gradually raised in order to determine its melting-point it fuses at about 200°, experiencing a thorough decomposition.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1884-5 will commence on Wednesday, October 1st, 1884, when the Prizes for the past Session and the Nursing Probationers' Prizes will be distributed at 8 p.m., by the Right Hon. the Lord Mayor, M.P., accompanied by the Lady Mayoress. There will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS value £60, £40, £30, and £20, will be offered for competition at the end of September to new students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free, and the holders of all the Resident Appointments are provided with rooms and board entirely free of expense. The Resident Appointments consist of Five House-Physiciancies, Five House-Surgeoncies, and one Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the Metropolis, and the Metropolitan, District, East London, and South-Eastern Railways have stations within a minute's walk of the Hospital and College.

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PATENTS DESIGNS & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to WILLIAM GEORGE STRYPE for the Invention of "Improvements in the Treatment of Blood to prepare it for use as a Manure or for other Purposes." Dated the 5th day of January, 1884, No. 787.

NOTICE IS HEREBY GIVEN that the said William George Strype has applied under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, for leave to amend the Complete Specification filed by him on the 9th February, 1884.

The Specification as proposed to be amended is open to inspection at the Patent Office, and full details of the proposed amendment were advertised in the Official Journal of the Patent Office published on the 1st August, page 279.

Any persons intending to oppose such application must leave particulars in writing of their objections to the proposed amendment at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C., within one calendar month from the date hereof.

Dated this 1st day of August, 1884.

H. READER LACK,
Comptroller General.
J. HENRY JOHNSON,
47, Lincoln's Inn Fields, London.
Agent for the said William George Strype.

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THE CHEMICAL NEWS.

VOL. L. No. 1291.

ON LOGARITHM TABLES.

By W. DITTMAR.

WOLLASTON's logarithmic sliding scale for the execution of chemical calculations has never been popular, and is now all but forgotten. The cause of this is easily apprehended: a four-place logarithm table does all that the best made scale can do, and a great deal more, with unerring certainty. But even four-place logarithm tables, although they just supply the degree of precision which we need for our ordinary analytical routine, are not much seen in chemical laboratories for the simple reason that the existing tables of this kind are not what they ought to be. They are all edited by professional arithmeticians who do not feel as an inconvenience what to most of us chemists appear as a positive nuisance. I refer to the trouble and time lost over the interpolations, which become particularly troublesome when the number for the logarithmic sum obtained has to be sought for.

All the four-place tables which have hitherto been published are arranged on the "double entry" system, which works so well with five- or more-place tables, but for four-place ones is not convenient. The logarithms, for instance, the numbers 100, 101 . . . 109, are all in *one* line, and within this line the difference between two successive logarithms is a variable quantity. Hence, if certain tables supply a ready calculated list of proportional parts for this line, it can be *correct* only for the mean value of Δ log, and when applied to other values leads to inaccuracies which a conscientious calculator does not care to tolerate. He rather calculates the correction from the particular value of Δ log which comes into consideration, and thus goes to an amount of trouble which renders the advantages offered by the logarithmic over the ordinary method of computing questionable, in the case of single calculations at least. This inconvenience, it is true, gets less and less as we proceed from num. = 1000 towards num. = 999, but in the beginning of the table it does exist to one's annoyance.

Many years ago I constructed for my own use a four-place table, arranged on the single entry system (like the well-known Lalande's five-place table), in which the intervals in the series of numbers were so chosen that the difference between two consecutive logarithms oscillated between about 0·0008 and 0·0011. The space thus gained was utilised for tables of proportional parts (customarily headed "P. P."), which gave directly the increments corresponding to $\Delta n = 1, 2, 3 \ldots$ *and* those corresponding to $\Delta \log = 1, 2, 3 \ldots$ units.

I never came to finally correct this MS. table because shortly after its compilation I hit upon what I thought was a better idea. For the execution of calculations for which four-place logarithms do not afford a sufficient degree of exactitude, I had procured a copy of the (now defunct) "Tafel der fünfstelligen Logarithmen und Antilogarithmen von Stegmann" (Marburg), and to make it more convenient in use I provided it with a lateral index (like that of a "where-is-it" book) which enabled one to put his finger on and turn up the couple of pages which contained the logarithm or anti-logarithm sought for. I subsequently came to substitute Wittstein's (beautifully printed) five-place table for Stegmann's, and did not miss the anti-logarithms much. In the case of the latter of course each individual index bore the (first three) figures of the initial logarithm as well as the initial numerals of the respective couple of pages.

By means of such an indexed five-place table four-place logarithms are furnished promptly, and, in general, without interpolation; and an un-interpolated four-place logarithm is uncertain by only what corresponds to 1-8600, &c., of the number, while the uncertainty in an interpolated logarithm from a four-place table is double this quantity, even if the correction be calculated in the orthodox fashion.

In a collection of "Tables to facilitate chemical calculations," which I compiled some time ago for myself and my students, and which is now passing through the Press, I have come back to my original idea, but carried it out in a slightly modified form. The series of numbers is as follows:—1000, 1002 . . . . 2004, 2006; 2010, 2015 . . . . . 4100, 4105; 4110, 4120 . . . . 9990, 10000. The P. P. columns are placed, each opposite the interval in the table to which it belongs, and they give the values of Δ (num.) corresponding to Δ (log) = 1, 2, 3 . . . . units respectively. For the interval num. = 3690 to 3790; for instance, the P. P.'s read as follows:—

$\Delta n =$	0·9	1·7	2·6	3·4	4·3	5·2	6·0	6·9	7·7	8·6
$\Delta \log =$	1	2	3	4	5	6	7	8	9	10

Now, the proposition $\Delta \log = k\ \Delta$ (num.), which we discount in interpolating, holds for negative increments as well as for positive ones; hence, in using the table there is no occasion ever to correct either a logarithm or a number for more than five units in the other variable. Interpolation thus is reduced to a very easy, in fact to an almost purely mechanical, operation.

A similar system might be adapted for the P. P. columns in five- or six-place tables; only in the case of the former it would be necessary to somehow make space for the lengthy P. P. columns. One mode would be to begin the table at numerus 2000 and carry it on to 20,000; such a table would just occupy the space of a table of logarithms *and* anti-logarithms for *numeri* 1000 to 10,000, and, apart from other advantages, in regard to the finding of the number for a given logarithm, be at more than a par with an anti-logarithm table of the ordinary range. Another method, less wasteful of space, would be to let the table cover the cycle num. = 1500 to 15,000; and from 1500 to 2000 or 2500, print on only every second or third line, so that page *one*, for instance, would go only from 150 to 162 (in its first column) instead of to 200. In this particular interval the difference between every two consecutive logarithms oscillates among 29, 28, and 27; and the P. P.'s for 29 would read as follows:—

$\Delta \log =$	1	2	3	27	28	29
Δ num. =	0·3	0·7	1·0	9·3	9·7	10

(For reasons which I have no space to explain, it would not do, in a five-place table arranged on the double-entry system, to let a P. P. column serve just for the interval opposite which it stands without either spreading out the table immoderately or introducing an appreciable uncertainty in addition to the unavoidable one).

In looking up log $(n+\Delta n)$ substitute for this given Δn the nearest Δn of the P. P. column, and add on (or subtract) the Δ log standing opposite to (in this article above) it. To find num. $(\log = l + \Delta l)$, simply add to numerus $(\log = l)$ the Δn opposite the Δl given. The latter operation would positively be easier than the former.

I originally intended to append such a five-place table to my "Tables," but shrunk from the expense, and, besides, found another good reason for at least shelving the idea.

Though not in the ordinary analytical routine, there *are* cases where one needs a higher degree of precision than that attainable with even a five-place table. Six-place logarithms suffice, we may well say, in all cases that present themselves in the chemical or physical laboratory. My practice hitherto used to be to use that beautiful seven-place table of Edward Sang's,* and cut off the last

* "Seven-place Logarithms of all Numbers from 10,000 to 200,000," by Edward Sang. Williams and Norgate.

figure. Of the existence of six-place *tables* I was hardly aware until I came across a review of such a table by Bremiker in a German journal. To satisfy my curiosity I procured a copy and used it for a series of calculations. I was quite surprised by the facility with which the table worked (in opposition to using a seven-place as a six-place) whenever I had to interpolate. It is, in fact, not easy to interpolate for six places direct from a seven-place table, and not to make blunders; one usually comes to interpolate to the seventh figure, and only at the end to cut off the seventh figure from the corrected logarithm. The result, then, is uncertain by only what corresponds to 1-860,000th of the number, while an interpolated logarithm taken from a six-place table is infected with twice this uncertainty. But even 1-430,000 is a higher degree of precision than we ever need even in high-class specific gravity determinations.

Having once got accustomed to lateral indices, I provided my six-place Bremiker with a system of indices contrived so that, by means of what I will call the principal index, I can at once open the book at the place where the left-hand page commences with the numerus 1000, 2000, 3000 . . . 9000, while subsidiary indices enable me to find the couple of pages commencing with numerus 4100, 4200, 4300 . . . for instance, at a second stroke.

A Bremiker arranged in this manner is the perfection of a *five- or six-place* table. It is only a pity that, like all German books, it is printed on very thin paper, and with a kind of type which, though magnificent in its way, is far too small to be the thing for my eyes, at any rate.

A table like it, but printed on good hand-made paper, and typographically at a level with Sang's, would be a boon to the chemical, physical, and perhaps I may add, astronomical community.

Anderson's College, Glasgow,
August 7, 1884.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JULY 31ST, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, August 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from July 1st to July 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 189 samples of water, the whole were, without exception, clear, bright, and well filtered.

Altogether, the quality of water supplied to the Metropolis during the past month, as indicated by its state of aëration and by its freedom from turbidity and excess of colour and organic matter, continued excellent. As commonly happens in July, the proportion of organic carbon found in the water, though still low, was a little in excess of that met with in June. Thus the mean quantity of organic carbon present in the Thames-derived water supply of the past month amounted to 0·123 part in 100,000 parts of the water, as against 0·114 part met with in the preceding month. This habitual slight rise in July is ordinarily followed by a more decided fall in August and September, to be succeeded, however, in its turn, by an appreciable rise in October and November.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A CONTRIBUTION TO THE STUDY OF THE ARTIFICIAL BLUE COLOURS, WITH REFERENCE TO WOOL-DYEING.

By W. ROSPENDOWSKI.

BEFORE proceeding to an enumeration of the products which we have to study it may be useful to call attention to a method of ascertaining whether a body is a homogeneous product or a mixture of several colouring matters. This very simple process consists in throwing a little of the powder into a glass of cold water. If the water in the glass is at rest we see coloured veins descend separately from each particle and fall to the bottom of the glass. If the specimen is a mixture of various dyes we obtain thus veins of different colours. It is of course evident that this method of examination cannot be applied to colours in solution or in a paste. By way of comparison there are given, firstly, the reactions of extract of indigo.

1. *Extract of Indigo.*

Sulphuric acid at 66° B. The colour does not change even if strongly heated with a large excess of acid. There is an escape of hydrochloric acid from the sodium chloride which is present here as well as in many aniline colours.

Caustic soda gives a light green precipitate, which if heated with a large excess passes to a yellowish brown and dissolves at a boil. If the yellow solution is acidified it turns to a blue lighter than the original colour.

Ammonia acts like soda, though the solution remains green and does not turn yellow.

Stannous chloride destroys the colour, whilst a grey turbidity remains.

With zinc powder the solution is decolourised on heating, becoming previously green. Ammonia or soda colours it yellow, which on exposure to the air passes gradually to orange and to a deep red, of the colour of iron sulphocyanide. This reddish brown solution, if shaken up with air in a test-tube, becomes first green and finally yellow. If the reduced solution has been mixed with ammonia and not with soda the final colouration is green. Both the yellow and the green solutions, if acidified, return to the original blue.

This change of colours is very characteristic of extract of indigo.

2. *Nicholson Blue B B B.*

(Of A. Poirrier and G. Dalsace, of St. Denis.)

Sulphuric acid at 66° B. The dry product gives with strong acid an orange-red solution. The dissolved product, with dilute acid, an abundant, very fine blue precipitate, quite insoluble even at a boil. An excess of strong acid dissolves this precipitate with a bronze-maroon colour, or in presence of a larger excess of acid, a brown

colour. This solution, if poured into a large excess of water, colours it the original blue shade.

Caustic soda: the solution does not change in the cold. On heating it becomes a red-brown. If acidified it resumes its original colour.

Ammonia: no change in the cold; a yellowish brown on heating; blue on acidifying.

Stannous chloride: the solution becomes turbid in the cold. On heating, a blue flocculent precipitate, very plentiful and completely insoluble. The liquid colourless.

Zinc-powder: the neutral or alkaline solution is not reduced even at a boil, but in this latter case it becomes yellowish brown, though without being reduced. An acid solution is decolourised on heating. This yellowish solution is not coloured on exposure to the air, but if heated with oxidising agents, such as potassium permanganate, it resumes its greenish blue colour.

Nicholson blue is a mono-sulpho-derivative of rosaniline blue (bleu de Lyon).

3. *Soluble Blue B B.*

(Lembach and Schleicher, of Biebrich on the Rhine.)

Sulphuric acid at 66° B. The aqueous solution gives with a little acid an abundant blue precipitate like that of the strong acid, from which it is distinguished by being slightly soluble in the acid liquid.

With an excess of the strong acid it behaves like Nicholson blue.

Caustic soda: the blue solution, with the very first drops and in the cold passes to a reddish brown, and on heating to a yellowish brown a little lighter. The blue colour returns on acidulating.

Ammonia: in the cold no change; on boiling it is decolourised, but the blue colour returns on acidulating.

Stannous chloride: a very delicate blue precipitate.

Zinc-powder: even the neutral solution is decolourised at a boil, but more easily if a few drops of sulphuric acid have been added. The colourless liquid when filtered does not change in the air, but if heated with permanganate in an acid solution the blue colour returns.

This blue is probably a bisulpho-derivative of rosaniline-blue. On wool it dyes directly, like indigo, taking care to acidify the beck gradually and to raise the temperature by slow degrees. Otherwise the colour becomes uneven.

4. *Induline B B B.*

(Williams, Thomas, and Dower, Brentford.)

With sulphuric acid at 66° B. the solution gives a heavy greenish blue precipitate in the form of a powder, and not flocculent, like Nicholson blue. This precipitate dissolves in an excess of the strong acid with a greenish blue colour.

Soda or ammonia: each of these reagents colours the solution of induline a reddish violet without any precipitate. At a boil the violet appears a little more pronounced.

Stannous chloride: a greenish blue precipitate, which is almost completely soluble at a boil with the same colour, and which reappears on cooling.

Zinc-powder: in a neutral solution induline is decolourised, but this liquid, slightly greenish, becomes quickly oxidised in the air, and resumes its blue colour. Zinc-powder mixed with sulphate of soda reduces it in the cold. The greenish yellow solution resulting is oxidised by the air with difficulty. In acid solutions the reduction is carried further. The liquid, when thus decolourised, does not resume its colour either in the air or on treatment with chromic acid, permanganate, &c. The molecule of the colouring matter is evidently broken up.

5. *Blue S S.*

(E. Patry and Co., Puteaux, Seine.)

Sulphuric acid: the solution is precipitated by the dilute acid as a very delicate blue powder; more distinct at a boil. With the strong acid there is formed at first a blue flocculent precipitate, which dissolves in an excess of h e strong acid with a blue colour rather more greenish than that of the aqueous solution. This colour does not perceptibly change even on boiling with a large excess of acid.

Soda or ammonia: this colour behaves exactly like induline; soda reddens the colour slightly more than ammonia.

Stannous chloride: a very delicate green precipitate, which on boiling becomes paler, but more decided.

Zinc-powder: the neutral solution is decolourised on heating, but resumes its colour in the air. Zinc-powder with sodium sulphate reduces it even in the cold to a greenish yellow liquid, which does not change in the air. Oxidising agents restore its original blue colour.

The primitive solution, decolourised by zinc-powder and sulphuric acid, even at a boil, resumes its colour with potassium permanganate and sulphuric acid.

Blue S S is very analogous to Coupier's blue, or sulphonised triphenyl-rosotoluidine.

This is a very fast colour, possessing such an affinity for wool that it must be dyed in a neutral bath which is very gently acidified.

6. *Marine Blue B B.*

(E. Patry and Co., Puteaux.)

Sulphuric acid: the dilute acid gives a very fine blue precipitate. With the strong acid this colour behaves exactly like Nicholson blue.

Soda or ammonia: the colour of the solution passes even in the cold to a reddish brown violet, which does not change on boiling.

Stannous chloride: a very copious and plentiful precipitate, either cold or hot. Zinc-powder: the solution is decolourised on boiling. The liquid thus reduced is only reoxidised with difficulty in the air, but it returns to its original intensity on boiling with permanganate and sulphuric acid.

This colour is closely analogous to the "Soluble Blue B B."

7. *Solid Blue.*

(Meister, Lucius, and Brüning, of Hœchst).

Sulphuric acid: absolutely like "Blue S S."

Caustic soda: violet-brown colour, not changing at a boil.

Ammonia: exactly as with "Blue S S."

Stannous chloride: a delicate greenish grey precipitate.

Zinc-powder: the liquid becomes a light yellowish green on boiling, but oxidises immediately in the air. In acid solutions the reduction by means of zinc-powder is more complete. The liquid is brown, and if filtered and mixed with permanganate it only turns to violet-red at a boiling, changing to a blue in presence of an excess of sulphuric acid. An excess of permanganate destroys this blue.

The aqueous solution of Solid Blue is slightly more reddish than that of Blue S S. It is probably a more alkaline salt than the latter, with which it is otherwise identical.

Solid Blue is dyed upon wool in the same manner as Blue S S.

8. *Solid Black Blue.*

(Meister, Lucius, and Brüning, of Hœchst.)

Sulphuric acid at 66° B.: throws down from the aqueous solution a deep blue powder, soluble in an excess of the strong acid, with a colour like that of indigo extract, and not changing at a boil.

Soda or ammonia: colour passes to a violet-red, not changing at a boil.

Stannous chloride: deep blue precipitate, becoming lighter on boiling.

Zinc-powder: complete decolourisation on boiling, but resuming its colour in the air. If reduced in an acid solution it presents exactly the same reactions as Solid Blue.

The properties of these two latter colours present no essential differences.

9. *Blue-Black B.*
(Baden Aniline Company).

Sulphuric acid at 66° B: at first a copious, flocky, deep blue precipitate, turning to green with an excess of acid. This intense green precipitate, if heated with a large excess of strong acid, gives a green solution, which changes to a bronze, and finally to a dirty yellow-brown. The colour is completely destroyed, being restored neither by excess of water nor by alkalies.

Caustic soda: the solution becomes more blue and does not change even at a boil with a large excess of soda. On cooling, there is a plentiful blue precipitate and a reddish liquid.

Ammonia: solution blue both cold and hot; no precipitate.

Stannous chloride: declourised on heating; colour entirely destroyed.

Zinc-powder: like the foregoing. This colour seems to be an induline and contains a considerable quantity of dextrine or of leiocome. Alcohol dissolves it with a reddish brown. The hot aqueous solution is of a reddish blue. When cold, there is formed a blue jelly, and the liquid becomes a light yellow-brown.

10. *Neutral Blue.*
(Cassella and Co., of Frankfort).

Sulphuric acid: in aqueous solution violet red.

An excess of strong acid turns it blue, which blackens a little when heated, but recovers on cooling. The blue solution, when poured into water, resumes its original colour.

Caustic soda: thick, tarry deposit, more blue than the aqueous solution; insoluble even at a boil.

Ammonia: precipitate and liquid more blue than with soda. This precipitate dissolves at a boil in an excess of ammonia with a violet-red colour, much more blue than the aqueous solution of the neutral colour.

Stannous chloride: black precipitate liquid, almost colourless.

Zinc powder: decolourised at a boil and on exposure to the air or on boiling with permanganate and sulphuric acid takes merely a light bluish rose colour. If reduced with zinc-powder in an acid solution it becomes a yellow liquid, which turns to a red-brown in the air or on treatment with oxidisers.

11. *Vat Indigotine.*
(Williams, Brothers, and Ekin).

Sulphuric acid: solution turns very slightly green; if boiled with a very large excess of the strong acid turns a dirty green.

Soda or ammonia: turns a violet-red, becoming slightly blue if boiled with an excess of the reagent.

Stannous chloride: deep blue precipitate, becoming lighter on boiling and apparently partially dissolved.

Zinc-powder: decolourised on heating, but resuming its colour in the air. Zinc-powder with sulphuric acid reduces it immediately; the yellow solution thus obtained becomes brown in the air. After being filtered, mixed with sulphuric acid, and heated, the blue colour is regenerated.

This colour must be applied to the fibre in the reduced state like vat indigo. It is not capable of direct application, like extract of indigo.

12. *Indigotine for Wool.*
(Santerre, Bourgeois, and Co.)

Sulphuric acid at 66° B: green flocculent precipitate, very plentiful; dissolves in an excess of the reagent with a bluish green colour, which scarcely changes on heating.

Soda or ammonia: solution reddened, more with the former than the latter. No change on boiling.

Zinc-powder: solution reduced at a boil, turning greenish yellow, turning to a reddish blue in the air. With zinc-powder and sulphuric acid a yellow-brown on boiling, turning to a bronze-black in the air, and resuming its intense blue on the addition of permanganate and sulphuric acid. An excess of permanganate destroys the colour.

13. *Topping Blue* (*Bleu Remontage*).
(Ch. Firmenich, of Geneva).

Sulphuric acid at 66° B: blue precipitate, soluble in excess, with a black colour. With a greater excess of strong acid the solution takes an orange-brown, which does not change on heating. If poured into water the blue colour returns.

Soda: brown colouration in the cold; considerable decolouration on boiling; blue colour restored on acidulation.

Ammonia: violet colouration; at a boil more complete decolouration than with soda; acid restores the original blue.

Stannous chloride: copious blue precipitate, soluble in excess, but re-appearing on boiling.

Zinc-powder: complete decolouration on boiling. The reduced solution is not changed in the air, but resumes its blue colour if heated with permanganate and sulphuric acid.

This compound should be a tri- or tetra-sulpho-derivative of rosaniline blue. It dyes wool directly in an acid bath.

14. *Gallocyanine and Solid Violet.*
(Durand and Huguenin, of Bâle).

Sulphuric acid at 66° B. The first drops give a red flocky precipitate, which dissolves afterwards with an amaranth red colour. With an excess of strong acid this colouration passes through a violet blue (the colour of as aqueous solution of gallocyanine) to a pure blue, very bright and intense.

On gradually diluting this blue solution with water, we have the same change of colours in the reverse direction.

Soda: on heating, the solution reddens a little, and loses its brightness.

Ammonia: reddens and loses more of its brightness.

Stannous chloride: in the cold a very copious blue, flocculent precipitate; liquid quite colourless; at a boil, with an excess of stannous chloride, the precipitate is decolourised and finally dissolved. The solution becomes blue again if heated with permanganate.

Zinc-powder: completely decolourised in the cold and more rapidly in heat, passing through a green. The colourless liquid readily becomes blue again on exposure to the air. If reduced by a mixture of zinc-powder and sulphuric acid the colour is only restored by oxidisers, and then but partially.

Chrome-alum: all the colour is precipitated in the form of maroon-brown flocks, the liquid becoming colourless. On heating, the precipitate turns to a violet-red.

It dissolves in ammonia with a fine blue, and in sulphuric acid with a rose-red.

Alum: a violet precipitate even in the cold, soluble in ammonia with a dull violet.

Gallocyanine dyes wool directly in an acid bath.

15. *Acid Myrtle.*
(L. Freund, St. Louis, Alsace).

16. *Liquid Green B.*
(P. Monnet and Co., La Plaine, Geneva).

17. *Solid Green, B, 2B, 3B.*
(P. Monnet and Co., La Plaine.

18. *Liquid Greens, No. 1, No. 2.*
(Verein Chem. Fabriken, of Mannheim).

All these colours are mixtures of malachite green and Paris violet.

Sulphuric acid: with very dilute acid a green colour; with strong acid, a yellowish brown, which blackens on heating and turns green on dilution with water. The yellowish brown solution, if poured into water, colours it blue.

Soda or ammonia: copious precipitate, at first a red-violet and then a chocolate colour; liquid colourless. When dried, the precipitate is a deep violet. On boiling, the precipitate disappears almost entirely, and the liquid resumes its blue colour when acidified.

Stannous chloride: green precipitate, soluble at a boil; solution green.

Zinc-powder: at a boil, complete decolouration and destruction of the colour.

After dyeing, the beck remains green, as the violet takes on the fibre better than the green.—*Moniteur Scientifique.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

APPENDIX.

ON DUMAS'S CORRECTION AND PROUT'S HYPOTHESIS.

In the year 1815 Prout put forth his famous hypothesis that the atomic weights of all the elements were multiples of that of hydrogen. His views were adopted by many chemists, but opposed by others; among them Berzelius and Turner; and down to the present day "Prout's Law" has been the subject of earnest controversy. Of course the fact was early recognised that in its original form the hypothesis could not stand, and accordingly it was modified by Dumas in such manner that half and quarter multiples of the atomic weight of hydrogen were considered as well as the whole numbers.

But of late years Prout's hypothesis, even with its elastic modification, has been in disfavour. Only a few chemists still clung to it as the representative of a veritable law. The researches of Stas were especially directed towards ascertaining its truth or falsity; and his results, as well as those obtained by Marignac, were such as to lead most chemists to the belief that it had been for ever overthrown. The atomic weights determined by Stas agreed neither with whole, half, nor quarter multiples of that of hydrogen, and the variations seemed to be wholly outside the range of recognisable experimental errors.

In 1878, however, a probable source of error in some of Stas's researches was pointed out by Dumas.† Many of Stas's ratios had involved the use of pure metallic silver, which had been fused under a cover of borax containing a little nitre. Such silver Dumas heated to redness in a Sprengel vacuum, and found that it gave up weighable quantities of oxygen, which had been absorbed by the metal when in the melted state. In one experiment a kilogrm. of silver gave 82 milligrms. of occluded gas, and in three other cases 226, 140, and 249 milligrms. respectively were found. In other words, the silver which had been considered pure by Stas and others was really not pure, and a correction became necessary in nearly all series of atomic weight determinations.

The amount of this correction, which I think may hereafter be appropriately designated as "Dumas's correction," will naturally vary in different cases, and in no particular case can we tell, without actual examination of the silver employed, exactly how great it should be. We may, however, assume that all the metallic silver heretofore used in establishing atomic weight ratios was subject to it; and, reckoning from the largest error indicated in the experiments of Dumas, namely, 249 milligrms. of oxygen in the kilogramme of metal, we may ascertain its tendency with reference to Prout's law.

In the chapter upon the atomic weights of silver, chlorine, bromine, iodine, potassium, sodium, and sulphur, twenty ratios are given, of which nine are subject to Dumas's correction. Applying it as suggested above, we get the following results. The values previously found and given in the chapter just quoted, we may designate as uncorrected. For convenience in future reference I assume that O = 16:—

	Uncorrected.	Corrected.	Difference.
Silver	107·923	107·896	−0·027
Chlorine	35·451	35·478	+0·027
Bromine	79 951	79·978	+0·027
Iodine	126·848	126·875	+0·027
Potassium ..	39·109	39·083	−0·026
Sodium	23·051	23·024	−0·027
Sulphur	32·058	32·058	—

The result of the correction, it will be seen, is generally favourable to Prout's hypothesis. Of the seven elements under consideration, one has its atomic weight unaffected, one is rendered less in accord with the hypothesis, and five approximate more closely than before to even multiples or multiples half of hydrogen.

In the later chapters of this work the effect of Dumas's correction is generally less striking. One general statement, however, may be made concerning it. Whenever the atomic weight of a metal is calculated from the ratio between its haloid salts and metallic silver, the total effect of Dumas's correction, including the above corrections for the halogens themselves, will be to *lower* the final result. This point will be further considered presently. Only chlorine, bromine, and iodine have their atomic weights raised by the correction.

In view of Dumas's correction the question naturally arises as to how far other metals, used in atomic weight researches, may occlude gaseous impurities. For example, when the atomic weight of oxygen is fixed by the synthesis of water over copper oxide, may not the copper occlude appreciable quantities of the hydrogen in which it cools? If it does, then the apparent weight of metallic copper would be too high, and the atomic weight of oxygen would come out too low. Such an error might possibly account for the difference between 16 and 15·9633 in the atomic weight of oxygen, and it would also increase the atomic weight of copper as determined by the same process. At all events, every metal of which the atomic weight has been determined by the reduction of its compounds in hydrogen ought to be scrupulously investigated with reference to the possible occlusion of gaseous impurities. With all of these metals the effect of such impurities would be to render the apparent atomic weights decidedly too high.

Although every series of atomic weight determinations must be considered by itself, and weighed on its own merits, it may not be out of place for me just here to point out two general sources of error in addition to the one we have been considering. First, every value after oxygen, with one or two partial exceptions, involves whatever error may attach to the atomic weight of oxygen. If the latter be 16, instead of 15·9633, this error in some instances becomes multiplied to a large fraction of a unit, as the subjoined example will show.

If O = 16, the atomic weight of uranium	= 239·030
If O = 15·9633, " "	= 238·482
Difference	0·548

Other similar errors are repeated continually. The value assigned to any element is necessarily affected by whatever errors may attach to the atomic weights of those other elements through whose medium it is compared with the standard, hydrogen, Thus, the atomic weight of carbon depends upon that of oxygen; calcium depends upon both carbon and oxygen; and fluorine, as determined from calcium fluoride, involves the foregoing elements, together with sulphur, silver, and chlorine. Since, however, some atomic weights are affected by plus errors and others by minus errors, there is a fortunate tendency to compen-

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Ann. Chim. Phys.* (5 s.), 14, 289.

ation of errors in cases like that of fluorine, and, in reality, better results are obtained than considerations such as these would lead us to look for.

Another general source of error is to be found in the fact that some of the weighings involved in our discussions had been reduced to absolute standards, while others were merely uncorrected weighings in air. The errors thus introduced into the work are doubtless small, but still they ought not to be absolutely ignored.

Now, having considered the larger classes of errors, we may properly pass on to a comparison of our atomic weights with reference to Prout's hypothesis. In order to facilitate work I have tabulated the figures in two columns, one giving atomic weights referred to hydrogen as unity, the other based upon the standard of oxygen as exactly sixteen. Such imperfectly known elements as decipium, philippium, samarium, terbium, and thulium are not included.

At the close of his admirable paper on the atomic weight of aluminum Mallet makes substantially the following argument in favour of Prout's hypothesis. Citing the atomic weights of eighteen elements which he considers well determined, he shows that ten of them have values falling within one-tenth of a unit of whole numbers. Now, what is the mathematical probability that this close approximation to conformity with Prout's law, in ten cases out of eighteen, is purely accidental, as those chemists who reject the hypothesis seem to hold? Working this problem out, Mallet finds the probability in favour of mere coincidence to be in the ratio of 1 : 1097·8, and hence he concludes that Prout's views are still worthy of respectful consideration.

Applying Mallet's reasoning to the table of atomic weights now before us, we find that in the first column, when H = 1, twenty-five elements out of sixty-six have values falling within the limits of one-tenth of a unit variation from whole numbers. But many of the figures which fall without this limit involve the variation of oxygen multiplied many times over. We must therefore study the second column, which assumes that the atomic weight of oxygen is exactly sixteen. Here we have forty elements falling within the limit of variation assigned by Mallet, and twenty-six falling without. The variations we may properly study in some detail.

Taking first the elements whose atomic weights vary from even multiples of unity by less than a tenth of a unit, we have to consider the following:—Aluminum, arsenic, barium, bismuth, boron, bromine, cadmium, cæsium, calcium, carbon, cobalt, columbium, didymium, fluorine, gallium, hydrogen, iridium, iron, lead, lithium, magnesium, manganese, nickel, nitrogen, osmium, oxygen, palladium, phosphorus, scandium, selenium, silver, sodium, sulphur, thorium, tin, titanium, tungsten, uranium, yttrium, and zinc. Of these, aluminum, arsenic, barium, bismuth, cadmium, calcium, carbon, cobalt, columbium, fluorine, hydrogen, iridium, iron, lithium, magnesium, manganese, nickel, nitrogen, phosphorus, scandium, sodium, sulphur, tungsten, uranium, yttrium, and zinc have plus variations, while boron, bromine, cæsium, didymium, gallium, lead, osmium, palladium, selenium, silver, thorium, tin, and titanium, fall slightly under the units to which they approximate. Oxygen, as the standard of comparison, of course shows here no variation, its possible error having been transferred to hydrogen.

Of the foregoing elements it will be seen that twenty-six have plus variations from whole numbers, while thirteen are minus. Among the latter, boron, gallium, osmium, palladium, thorium, and titanium have been but roughly determined. Bromine, by Dumas's correction, has its variation diminished. In the cases of lead, cæsium, selenium, and tin, the cause of variation, supposing one to exist, remains to be determined. The value for osmium is undoubtedly several units too high, so that its agreement with Prout's law may be considered purely accidental. As for didymium, the figure assigned is the mean of all determinations; whereas Cleve's data, calculated with SO_3 = 80, make Di = 147·021, a variation which, like most of the others, is far within the limits of ordinary experimental error. In the case of silver it has already been shown that Dumas's correction is unfavourable to it considered in its bearings upon Prout's law. Silver is the only element among those having minus variations which could carry very much weight against the hypothesis.

Among the elements whose variations are plus, columbium, uranium, and yttrium have been poorly determined. Yttrium especially may be considered doubtful. The atomic weights of aluminum, arsenic, barium, cadmium, lithium, phosphorus, and sodium involve Dumas's correction to a greater or less extent, and will be lowered by its application, that is, brought nearer to whole numbers. For aluminum, certain other causes for variation were pointed out in the chapter upon that metal; and it may be noted that the direct ratio between it and hydrogen gives Al = 27·998 ± 0·007. Here the variation is less than the probable error. For calcium, and consequently for fluorine also, sources of plus error were indicated in the discussion of their respective atomic weights, and reiteration here is unnecessary. Cobalt, iridium, iron, nickel, and tungsten all involve such errors as may arise from the possible occlusion of hydrogen by the metals after reduction from their compounds. For scandium, the atomic weight, calculated with SO_3 = 80, becomes 44·032, a variation much within the limits of experimental error. For carbon and bismuth the variations are insignificant. In short, in the majority of instances the errors may be diminished by corrections which are in all probability needed, and which can be easily pointed out. The more carefully we scrutinise the data the more probable Prout's hypothesis appears.

Among the twenty-six elements whose atomic weights are removed by more than a tenth of a unit from whole numbers, chlorine, rubidium, and strontium have values nearly half multiples of that of hydrogen, and in each case Dumas's correction will make the approximation still closer. Erbium, gold, indium, lanthanum, rhodium, ruthenium, silicon, and zirconium, may be dismissed from consideration as too imperfectly determined to carry much weight in the present discussion. For chromium, copper, molybdenum, and vanadium I have no criticisms to offer; but the remaining elements may be considered individually.

The value assigned to antimony, 120·231, is the general mean of Cooke's and Schneider's work upon the bromide, iodide, and sulphide. If Ag = 108, Br = 80, and I = 127, Cooke's data for the bromide and iodide give the following values for Sb, all of which fall within a tenth of a unit of the whole number 120:—

Early bromide series	.. ..	Sb = 219·901
Late ,,	.. ..	,, 120·009
Iodide series	.. ..	,, 119·973

In the case of cerium, the value assigned in the table is the general mean of all reputable determinations. But it is subject to doubt on account of the facts observed by Wolf and by Wing, whose ceroso-ceric oxide was white, while that of all other observers was yellowish. Wolf's and Wing's data, calculated with O = 16, give Ce = 138·039. Cerium, then, is not an *established* exception to Prout's law.

Glucinum and ytterbium have their atomic weights calculated from analyses of the sulphates. But if Prout's law is true, SO_3 = 80. Calculated with this figure, we have Gl = 9·096 and Yb = 173·016. Both elements thus fall within reasonable limits of variation from the hypothetical values.

Iodine is one of the most important seeming exceptions. If we assume Ag = 108, and calculate the atomic weight of iodine only from the direct ratio between iodine and silver, we have with Dumas's correction applied, I = 126·996; that is, it comes within oue-tenth of a unit of the whole number 127.

The atomic weight of mercury depends upon analyses

TABLE OF ATOMIC WEIGHTS.

	H = 1.		O = 16.	REMARKS.
Aluminum	27·009	± 0·003	27·075	
Antimony	119·955	0 036	120·231	Cooke's and Schneider's data.
Arsenic	74 918	0·016	75·090	
Barium	136 763	0·031	137·007	
Bismuth	207·523	0·082	208·001	From Schneider's data.
Boron	10·941	0·023	10·966	
Bromine	79·768	0·019	79·951	
Cadmium	111·835	0·024	112·092	
Cæsium	132·583	0·024	132·918	
Calcium	39·990	0·010	40·082	
Carbon	11·9736	0·0028	12·0011	
Cerium	140·424	0·017	140·747	Buehrig's data give 141·523. (O = 16).
Chlorine	35·370	0·014	35·451	
Chromium	52·009	0·025	52·129	From Siewert's data.
Cobalt	58·887	0·008	59·023	
Columbium	93 812		94·027	From one ratio only.
Copper	63·173	0·011	63·318	
Didymium	144·573	0·031	144·906	Cleve's data give 147·021 (SO_3 = 80).
Erbium	165·891		166·273	From Cleve's data only.
Fluorine	18·984	0·0065	19·027	
Gallium	68 854		68·963	Imperfectly determined.
Glucinum	9·085	0·0055	9·106	Nilson and Pettersson's data.
Gold	196·155	0·095	196·606	
Hydrogen	1·0000		1·0023	
Indium	113·398	0·047	113·659	
Iodine	126·557	0·022	126·848	
Iridium	192·651	0·033	193·094	Seubert's data.
Iron	55·913	0·012	56·042	
Lanthanum	138·526	0·030	138·844	
Lead	206·471	0·021	206·946	
Lithium	7·0073	0·007	7·0235	
Magnesium	23·959	0·005	24·014	Marchand and Scheerer's data.
Manganese	53·906	0·012	54·029	Schneider and Rawack's data.
Mercury	199·712	0·042	200·171	
Molybdenum	95·527	0·051	95·747	
Nickel	57·928	0·022	58·062	Schneider, Sommaruga, and Lee.
Nitrogen	14·0210	0·0035	14·029	
Osmium	198·494		198·951	Very doubtful.
Oxygen	15·9633	0·0035	16·000	
Palladium	105·737		105·981	Badly determined.
Phosphorus	30·958	0·007	31·029	
Platinum	194·415	0·049	194·867	Seubert's data.
Potassium	39·019	0·012	39·109	
Rhodium	104·055		104 285	Badly determined.
Rubidium	85·251	0·018	85·529	
Ruthenium	104·217		104·457	Badly determined.
Scandium	43·980	0·015	44·081	
Selenium	78·797	0·011	78·978	
Silicon	28·195	0·066	28·260	Very badly determined.
Silver	107·675	0·0096	107·923	
Sodium	22·998	0·011	23·051	
Strontium	87·374	0·032	87·575	
Sulphur	31·984	0·012	32·058	
Tantalum	182·144	0·166	182·562	
Tellurium	127·960	0·034	128·254	Imperfectly determined.
Thallium	203·715	0·0365	204·183	Crookes's data.
Thorium	233·414	0·073	233·951	
Tin	117·698	0·040	117·968	
Titanium	49·846	0·064	49 961	Imperfectly determined.
Tungsten	183·610	0·032	184·032	
Uranium	238·482	0·082	239·030	
Vanadium	51·256	0·024	51·373	
Ytterbium	172·761	0·038	173·158	If SO_3 = 80, Yb = 173·016.
Yttrium	89·816	0·067	90·023	Doubtful.
Zinc	64·9045	0 019	65·054	Axel Erdmann's data.
Zirconium	89 367	0·037	89·573	Doubtful.

of the chloride, oxide, and sulphide. Of these three compounds the purity of the chloride is most easily assured. Calculated from its composition, with Cl=35·5 Hg= 199·971. With so high an atomic weight small errors are easily multiplied.

For the atomic weight of platinum Seubert's data give five values, ranging both above and below the round number 195. Calculated with integer values for the other elements, three of these figures fall very close to 195, as follows:—

From p. c. Pt in $(NH_4)_2PtCl_6$ .. .. Pt = 194·906
,, ,, K_2PtCl_6 .. .. .. ,, 194·933
From chlorine estimation in K_2PtCl_6.. ,, 194·955

Potassium is the most serious exception of all. But if O = 16 and Dumas's correction be applied, the general mean from all the available data becomes K = 39·083. That is, potassium falls within the limit of o 1 variation.

The atomic weight assigned to tantalum is the mean of four values. Two of these, re-calculated with integers, come out as follows:—

From p. c. K_2SO_4 in K_2TaF_7 .. .. .. Ta = 181·912
,, Ta_2O_5 from $(NH_4)_2TaF_7$.. .. ,, 182·020

For tellurium I need only call attention to the discrepancies between the several sets of determinations made by Wills. A reference to the chapter on tellurium will show that his figures give results ranging from Te = 126·07 to Te = 129·34. The mean value is therefore too much subject to doubt to carry weight as an exception.

As for thallium, the last case to be considered, I have already shown that Crookes's data, re-calculated with integer values for N and O, give Tl = 204·008. That is, instead of an exception, we have here an admirable instance in support of Prout's hypothesis.

Enough has been said in this brief resumé to show that none of the seeming exceptions to Prout's law are inexplicable. Some of them, indeed, carefully investigated, support it strongly. In short, admitting half multiples as legitimate, it is more probable that the few apparent exceptions are due to undetected constant errors, than that the great number of close agreements should be merely accidental. I began this recalculation of the atomic weights with a strong prejudice against Prout's hypothesis, but the facts as they came before me have forced me to give it a very respectful consideration. All chemists must at least admit that the strife over it is not yet ended, and that its opponents cannot thus far claim a perfect victory.

The following additional note has been communicated by the author:—

This chapter, which here stands as it was originally written, was first published in January, 1882. Since then, new determinations have appeared concerning the atomic weights of C, Rb, Mg, Zn, Mn, Cu, Ni, Cr, Al, Sb, Bi, Ti, Th, Di, La, Y, and Sm. Many of these indicate no serious changes in the values I had adopted; but, as will be seen by referring back to my footnotes, fundamental alterations must be made in the cases of Mn, Ti, Th, La, Di, Y, and Sm. These, however, do not affect in any general way the conclusions herein drawn relative to Prout's law; in fact, their tendency is rather to confirm it. Hence I have felt that it is hardly yet necessary to re-write or revise the chapter, but have preferred to leave it as it first appeared. The following figures may, however, be substituted for those given in the table:—

	H = 1.		O = 16.
Mn..	54·855	± 0·016	54·981
Ti	47·980	0·032	48·100
Th..	232·020	0·032	232·554
La..	138·019	0·025	138·336
Di	142·121		142·502
Y	88·900	0·027	89·104
Sm	149·801		150·145

F. W. C.

Theoretic Figure of Certain Simple Bodies forming a Series.—The author proposes to examine what may be the relations of forms between the atomic weights of the metals of the first series. He attempts to localise geometrically the proto-atoms (of hydrogen according to Prout) on the summits, or surfaces, or ridges of regular figures.—*Comptes Rendus.*

PASTEUR AND THE GERM THEORY.*

By FREDERICK J. FARADAY, F.L.S.

(Concluded from p. 74).

12. Modern scientific ideas and discoveries do not so much displace old ideas as spring from them. There is usually a certain basis of experience for the old ideas, and experience is really a basis of fact which much be true. Hence it is natural that enquirers into the variability of germs and their pathogenic relations should turn to oxygen as being likely to play an important part in this connection. The influence of oxygen as a purifier of water attracted the attention of Dr. Angus Smith long before Pasteur's attenuation experiments. As he himself has explained, this was a natural consequence of the ideas of the older chemists as to the influence of oxygen as the active agent of decay. Again, the value of ventilation and fresh air in cases of consumption was insisted upon by medical men long before Koch's discovery of the *Bacillus tuberculosis*. From the beginning of his enquiries Pasteur has been strongly disposed to regard oxygen as an attenuating agent, or, in other words, as an agent for reducing the parasitic virulence of germs. For it may be suggested that the ability or habit of a ferment to tear highly complex organic compounds to pieces, so to speak, in order to procure the oxygen which, under other circumstances, it would obtain in the free state, is a kind of parasitic quality. Philosophically, the anærobie which feeds upon dead organic matter may be considered as an intermediate between the innocent ærobic saprophyte and the deadly anærobic parasite which feeds upon the living tissues or fluids. Therefore the question presents itself whether the presence of free oxygen, and the proportion in which it is present with other gases, may be regarded as having really an educational influence upon the innocent saprophyte. In an early report upon graveyards Mr. David Chadwick mentions a case of a man having been struck dead by a single puff of air from a long-closed vault in which the dead had been interred, whereas no such accidents happen in country churchyards. Again, Dr. Angus Smith has called our attention to the fact that the emanations from moving waters like the Clyde, open to the free air, though they may cause sickness, do not cause fevers; whereas the emanations from covered sewers, where the atmosphere will have a very different character to that over the Clyde, and from closed tombs and vaults, do cause fevers, and, as in the case mentioned above, even sudden death. But surely we cannot assume that the specific germs of typhoid, say, deliberately remain in the sewer and shun the river; or that specific agents of decay enter the vault beneath the city church and shun the country churchyard. We can scarcely draw a line beyond which no disease germ will venture to go. After all, therefore, the difference between the typhoid germ in the sewer and the germs in the river, the ferments in the country churchyard and those in the unventilated vault, is one of virulence; in other words, the river germ is an attenuated germ, and the reason why it produces nausea, let us say, only, and not fever, is because it is not strong enough to overcome the vital force of the person attacked. Undoubtedly there are various degrees of virulence. Apart even from Pasteur's wonderful "vaccine" experiments we know that there are mild and severe fevers, various degrees of diarrhœa, of which Asiatic cholera (according to Jules Guerin and Sir William Hunter) may be the most virulent form, and various degrees of small-pox. In the Board of Health Reports on the cholera epidemic of 1848-9 it is stated that distinct warning of its approach was given in every European city by the prevalence of intermittent fever, dysentery, and especially diarrhœa; and reports on subsequent epidemics have so fully confirmed this observation that it may be taken as an axiom that cholera is always preceded

* A paper read before the Manchester Literary and Philosophical Society, April 15, 1884.

by epidemic diarrhœa. To a certain extent we may therefore provisionally regard the nature of the gases in which microbes find themselves, in comparison with what I will call the standard of pure air, as determining the degree of parasitic virulence. In a paper read at the meeting of the British Association at Southampton I ventured to suggest that the development of the tubercle bacillus as a deadly parasite might be due, so to speak, to its imprisonment in lungs inefficiently aërated, either in consequence of hereditary structure inducing weak breathing habits, the habitual breathing of air containing less than the healthy proportion of oxygen, or the choking of the air passages through catarrh or the inhaling of dust. Miquel points out that the proportion of "young" microbes is exceptionally large in sewers, where old or exhausted microbes are rare.

13. But if we assume degrees of virulence from harmless to deadly in one and the same species, we imply a gradation from saprophyte to parasite, and from ærobie to anærobie. For even if attenuation by means of free oxygen be regarded as the slow killing of the parasite, we can scarcely assume that free oxygen has been always fatal to the parent forms; for in that case how could we realise the possibility of zymotic diseases having ever begun, unless we trace them back to some time when poisonous vapours enfolded the earth? And, granted various stages of virulence from harmless to deadly in one and the same species, how are we to define the difference of species? We may define species pathologically by the different symptoms of the diseases with which they are associated, and to some extent possibly by the forms of the microbes. We may also classify microbes by the marked differences of their own constitutions. For the susceptibility of these organisms seems to differ in the most extraordinary fashion. What is meat for one appears to be poison for another. Thus, in his latest report on the cholera bacillus, Koch tells us that the smallest proportion of acid is fatal to the life of that organism, yet we know that other bacilli live and thrive in strongly acid solutions. Ideas bearing upon these later discoveries have long been current; witness Dr. Angus Smith's remark in 1848, that a man might be capable of one disease on one day and another disease on the following day. Perhaps the peculiar susceptibilities of the microbes may be developed and fixed as the peculiar virulence is developed and fixed. The desirableness of further experiments on the cultivation of organisms in various gases, and particularly on the cultivation of the spores, is strongly suggested by these considerations. It would also be worth while to test further the specific consequences of the presence or absence of light.

14. The presence or absence of oxygen is associated with the the question of spore formation. In this connection the varying susceptibility or vigour of microbes, not only in different animals, but in different *milieux* in the same animal, must not be overlooked. Thus the virus of the Maladie de Chabert, or *Charbon symptomatique*, formerly supposed to be the same disease as anthrax, acts as a vaccine if injected directly into the blood, while in solid tissues the same culture produces fatal results, according to the experiments of MM. Arloing, Cornevan, and Thomas. The law which M. Paul Bert has deduced from such observations is, that any condition which arrests the development of a virus converts it into a vaccine, and this implies the principle that specific microbes thrive better, or attain their maximum virulence, in certain tissues or juices, and are attenuated in others. Most remarkable series of observations have been made with respect to the varying effects from harmlessness to fatality of special microbes in different animals. These have led Pasteur and his assistants, MM. Chamberland and Roux, to the idea that differences of temperature affect the vigour of the microbes, and thermal conditions have been employed as a means of attenuation in the production of protective cultures. Thus the usual immunity of birds against anthrax inoculations is attributed by Pasteur to the high temperature of their blood, and he claims to have developed anthrax in the fowl by keeping its body in cold water. We must not, however, overlook, nor does Pasteur overlook, the possibility of the variation in the susceptibility, or vigour, being not on the side of the microbe, but on the side of the animal. Thus Koch claims to have developed anthrax in birds in spite of their high temperature, and he suggests that the fowl in Pasteur's experiment fell a victim, not because of any change in the microbe, but because the fowl's own vitality was lowered, weak animals succumbing to ailments which in health they would successfully throw off. These views distinctly admit the idea of a definite struggle for existence between the microbe and the cells of the living animal. Pasteur's views as to the influence of a few degrees more or less of heat on the specific vitality of the microbe are, however, supported by the experiments of Willems, and later of Arloing, Cornevin, and Thomas, on the development of inoculations in different parts of the body. Thus inoculations in the tails of cattle proved ineffective, but when the temperature was artificially increased the specific disease developed. These ideas have a bearing upon the greater or less success of vaccinations according to the time of year when they are practised and the surrounding conditions of temperature; and also upon the appearance of epidemics at particular seasons and in particular years. Finally, with respect to the special relations between the specific microbe and different tissues, it may be mentioned that the special nidus of the virus of rabies appears to be the nerve-centres.

15. In regard to all these phenomena, the question of spore formation cannot fail to attract attention, and the relation between spore formation and the presence of oxygen might prove a fruitful subject of inquiry. Klein's most ingenious experiments on the cultivation of *Bacillus anthracis* in gelatine pork tend to show that spores are not formed except in the presence of free oxygen, and in opposition to Pasteur he maintains that anthrax spores are never formed in the bodies of animals. On the other hand, Miquel's observations on bacilli in general appear to agree to some extent with Pasteur's opinions. He says: "We may experimentally induce the formation of bacillus spores by depriving the bacilli of oxygen, or in determining the slow death of the adult forms by antiseptics, but evidently not by killing them rapidly, as then all vital phenomena cease and spores cannot be formed. The best way in which to obtain bacillus spores rapidly appears to me to be by enclosing nutritive infusions charged with filamentous bacilli in sealed tubes containing very little air." There is much obscurity and contradiction on this point, which may be due to all the conditions not having been duly considered, and it seems to offer a most promising field for investigation. Meanwhile the question arises whether the so-called spores are really the terrible things we are inclined to suppose them. There are some noteworthy phenomena connected with spore formation. Pasteur maintains that anthrax has been spread amongst cattle and sheep by the bringing up of spores from buried carcases by earthworms, which is opposed to the opinions of Koch and Klein that no spores are ever formed in the bodies of animals. Again, Klein has found that cultures of *Bacillus anthracis*, which are fatal to rabbits and guinea pigs, whether forming spores or not, are only fatal to mice when they are spore-forming cultures. In considering all these various results we must bear in mind that there are several modes in which the life of the higher organism may be destroyed. The phenomenon may be simply a struggle for existence between the microbes and the vital cells of the animal body, in which the strongest survives, death resulting from the destruction of the function of the parts invaded, the loss of nutriment, or their absolute change into another form of life, morbid growths or microbe life resulting from the dissolution of the tie which holds the cells together as a community; or the products of the fermentive action of the microbes may

be poisonous, or may be poisonous in the particular channels in which they are produced; or finally, as Dr. Cameron has suggested, the fatal result may be due merely to the mechanical obstruction offered by millions of microbes blocking up the capillary circulation. Vastly extended threads of mycelium growth would, of course, have such a mechanical effect, Now, from the vitality of spores, the fact that they resist destruction up to 110° C. of heat, and that they seem to retain their specific life for indefinite periods, it is possible that we may be too much disposed to malign them. Of the two modes of reproduction, the multiplication by scissiparity and the multiplication by spores, may not the former be, at least in some cases, the true disease form? Spores, if cultivated in suitable infusions, will apparently reproduce the *Bacillus anthracis* of the parent cultures, and inoculations with such cultures will kill with typical anthrax. But have we sure evidence that inoculation with pure spores would be fatal? Klein's mice experiments already referred to seem to show this. It is conceivable, however, that spores may require a suitable dead medium for their development, and that only the living organism, when developed, is able to contend as a parasite with the living cells of the animal body. It is at least a remarkable fact that experiment and observation are more and more tending to associate the communication of disease with liquids and moisture in which the bacilli are developed, rather than with atmospheric influences. Koch finds that desiccation is speedily fatal to the cholera germ, and we know that the communication of the disease is apparently associated peculiarly with the washing of infected linen. The statement of Miquel that he has entirely failed to develop disease in rabbits or guinea-pigs by means of germs collected from the atmosphere may have a bearing on this question. Of course, as Miquel observes, failure with rabbits and guinea-pigs would not necessarily imply failure with human beings, on whom experiments have not been tried. This does not affect the question of septic germs in hospitals. There may well be spores which, though unable to develop in living and healthy tissues or fluids, may find the suitable preliminary medium of culture in morbid secretions or dying tissues, as in wounds or in accumulations in the lungs or intestines when the bodily functions are disordered. Thus the spores of the cholera bacillus may pass safely with undissolved food through the acids of the stomach which would destroy the bacillus, and subsequently develop in the intestines. The general principle would be that a body in a bad state of health affords the preliminary conditions of nourishment necessary for the development of the vigorous parasite.

16. The consideration of the question of spores, of nuclei, and of the granulations into which non-spore producing bacillus threads crumble, leads to the inquiry, whence come all the varied forms of microbe life? There is scarcely any, if there is any fluid, in which these minute forms are not present. Dr. Angus Smith tells us that even in very pure spring water he finds them doing chemical work. They are present in the saliva, apparently elaborating a specific alkaloid; they are traceable in every organic fluid which has not been sterilised by heat. Under the microscope they "come like shadows, so depart." Leeuwenhoek wondered that his mouth should contain more living beings than there were people in the States of Holland, and modern microscopic investigation is certainly giving a kind of basis to the fancies of Rabelais and Swift. Are our failures to convert different species of microbes, to establish physiological polymorphism, due to the circumstance that we do not begin with the original forms? The essence of Darwinism is not that the cat has been developed from the lion, or the tiger from either, but that all have proceeded from some more primitive form. Possibly *Bacillus anthracis* is not a "sport" from *Bacillus subtilis*, but both are parallel developments from some more simple organism. There is a certain fascination in the ideas of Béchamp. According to Béchamp it is from the granulations, from certain apparently amorphous structures observable in organic liquids under the microscope, that all the forms of organised life are evolved, according to the conditions of culture. Béchamp believes in the continued existence of such microzymes in chalk and other geological formations of the life of past geological epochs. The rocks themselves include the germs of life. This seems to be a reproduction of the idea of Buffon respecting the existence of organic molecules, as Pasteur has pointed out; and Béchamp in fact admits that it is. As already remarked, Pasteur does not absolutely refuse to admit the possibility of such an hypothesis; all that he says is that the experiments which are said to have proved its truth are unsatisfactory, and that it is so far absolutely without proof, no such evolution as that implied having been artificially accomplished. The idea in Béchamp's mind is, however, essentially different from the idea of spontaneous generation; Béchamp's granulations are latent germs to begin with, which may, according to their special surroundings, be differentiated into all the forms of life. In the egg they are subservient to the special life-history of the animal and are differentiated with organs resembling those of the parent structure. But freed from that mysterious vital bond which holds the community of cells together, each microzyme falls away into an independent existence and may become a bacterium, or bacillus, or vibrion. Thus, the apparently dead body is not dead, it is simply the bond of union and co-operation which is broken, and the structure is resolved into its still living molecules. Nothing, says Béchamp, is the prey of death; all is the prey of life. Such an hypothesis would of course explain the appearance of microbes in organic fluids without the intervention of germs from the atmosphere being invoked. To the experiments of Pasteur showing the non-development of life in solutions previously heated, if atmospheric germs are rigorously excluded, Béchamp replies that the heat which has sterilised the fluids has destroyed the microzymes. Pasteur in reply has carefully introduced blood direct from the living animal into purified tubes from which all atmospheric germs were excluded, and still without developing fermentation or life in such fluids. This almost seems like a conclusive experiment, but Béchamp is not convinced, and may indeed reply that a negative result proves nothing in this case, as the conditions may not have been suitable for the development of the special microzymes present in the blood. On the other hand, there are analogies which are worth noting, and which suggest that there may be truth on both sides. Béchamp cites the fermentation of ostrich eggs, whose thick, ivory-like, and unbroken shells excluded, he contends, all atmospheric life. In these cases, however, his microzymes do not appear to have become microbes. To Pasteur's discovery of the corpuscles of *pébrine* in the eggs of the silkworm, he replies that eggs contain many microzymes, and that the peculiar disease corpuscles are simply microzymes which have inherited the bad tendency developed in the microzymes of the parent moth and chrysalis. Without forming any decisive opinion on this mysterious and profound question (for what can appear more astonishing than the continued life of a parasite, not merely in the body of the parent worms, but actually in the eggs laid by the moths?) attention may be drawn to the analogy between the remarkable variety in the susceptibilities of microbes and the apparently specialised chemical work of different ferments, and the specialised chemical elaborations of the cells of different organs of the animal body. Are not many diseases of the human system, for instance, apparently due to the excessive activity of specialised secreting cells, or to the development of similar power of chemical elaboration by other cells; to an apparent change of function, as though secreting cells of a given order were working in the wrong places? And are not such phenomena analogous to the introduction into the blood or tissues of disease microbes endowed with special chemical activities of their own?

17. In the course of this paper, mention has been made of the education of microbes. The idea has a bearing

upon Pasteur's astonishing protective vaccination discoveries, and seems to have a relation to the mysterious phenomenon of heredity. The microbes of particular diseases, when passed from animal to animal, increase in virulence; thus, as Pasteur as shown, the microbe, which was originally powerless to kill a guinea-pig a week old, but which killed a guinea-pig a day old, has been nursed into a breed capable of killing a sheep. Yet there is apparently no specific change in the successive generations of bacilli; we must assume that the chemical constitution of their bodies remains unchanged, that they are essentially identical in structure; the only change is in the vigour of their life, developed hereditarily. What is vigour, what is life, what is heredity? When we turn now to the animals in whom the zymotic diseases do not recur, and to the phenomena of protective vaccination, may we not assume that some educational influence of the same kind is exerted upon the living cells of the animal body?

The microbe which kills the unvaccinated animal is the same, in all respects, as the microbe which fails to kill the vaccinated animal; the difference is in the cells of the animal attacked. When it is suggested, as in the case of small-pox for instance, that the vaccination has used up some material, only rarely elaborated, in the body, and necessary for the development of the microbe, are we not guilty of as crude an attempt to represent the fact, as was the old notion of a material caloric? May we not with more philosophy regard the phenomenon as some mysterious educational influence, in the one case, as well as in the other. Regarding the contest between the microbe and the living cells of the body as a struggle for existence, may we not assume that resisting vigour is developed in the one, as attacking vigour is developed in the other? Miquel records a most remarkable instance which he says "seemed to show that bacteria are endowed with instinctive movements." A bacillus making a circular movement was arrested by a mass of germs. It vigorously attacked the mass, and by rapid backward and forward pushes, attacking now right, and now left, cleared a *cul-de-sac*, which it finally developed into a complete canal; then it appeared to rest from its efforts. Miquel was utterly astonished by the "address" with which the bacillus thus disengaged itself from the vicious circle in which it found itself engaged. Is there anything more wonderful in this than in the apparently instinctive movements observed by Darwin in the tips of the radicles of plants, the apparently muscular memory to which Romanes calls attention as the real import of the phrase that "practice makes perfect"? Smokers, for instance, know that they have overcome the nausea of the first mild cigar, and educated the cells of which they consist into the enjoyment even of strong Havanas. It would seem as though in nature no experience fails to leave its impress and its influence. When we consider how minute is the germ, even of the most intelligent vertebrate, which reproduces not only the specific form and structure of the parent, but its instincts and—excepting perhaps man—the influence of the experience of its ancestors, it cannot seem too wonderful to suppose that the protective influence of vaccines may be due to the operation of the same mysterious principle, and that the discoverer of the physical cause of protective vaccination will discover the nature of memory and heredity. Such a problem may well be insoluble, and the scientific man, like the Athenians of old, may have to content himself simply with the recognition of the existence of the unknown; but there is no more reason for discrediting the facts of protective vaccination because they are beyond explanation, than there would be for discrediting the facts of memory, heredity, or life itself. Reasoning from analogy, there is an inherent probability in protective vaccination. Reduced to its ultimate expression, animated nature would appear to consist of Buffon's organic molecules *plus* the principle of organic memory, as inorganic nature is inert matter *plus* the principle of motion.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 4, July 28, 1884.

Researches on Flour: Distribution of Acidity and Sugar in the Various Products of Grinding.—M. Balland.—Acidity is unequally distributed, being less plentiful in the flour than in the other products. The normol acidity of flour estimated as sulphuric acid appears to range from 15 to 40 grms. per metric quintal. In recent flour sugar exists from 0·80 to 2·20 grms. per cent.

Temperature and Critical Pressure of Liquid Air. Relation between the Temperature of the Liquid Air and Atmospheric Pressure.—K. Olzewski.—The author uses air as a refrigeratory agent. He has obtained 6 c.c. in a liquid state and submitted it to evaporation at the pressure of 1 atmosphere or even in a vacuum. In the latter case he has obtained a temperature of −205°. That of nitrogen evaporating in a vacuum he supposes to be −213°.

New Method for the Direct Measurement of Absolute Magnetic Intensities.—A. Leduc.—The author applies for this purpose the mercurial galvanometer recently discovered by M. Lippman.

Combustion of Detonating Gases in Different States of Dilution.—A. Witz.—The author concludes that the action of the sides of the containing vessel or tube is the great regulator of explosive phenomena. The dilution of an explosive mixture produces a somewhat similar effect.

Determination of Nitric Acid by Precipitation as Cinchonamine Nitrate. Application of this Process to the Determination of Nitrates in Natural Waters and in Plants.—M. Arnaud.—This paper will be inserted in full.

On the Tri-acetic Ether of a Butylic Glycerin.—L. Prunier.—The existence of this tri-acetine contributes to fix the tri-atomic function of the butylic homologue of ordinary glycerin.

Method for Determining the Dry Extract of Wines.—E. H. Amagat.—For the determination of the dry residue the author proposes to substitute that of the specific gravity after the alcohol has been expelled by boiling and the sample has been restored to its original volume by the addition of water. For a wine containing 35 grms. of extract per litre taken in a vacuum the specific gravity of the de-alcoholised liquid is 1·0140; for one yielding 10 grms. it is 1·0040.

Moniteur Scientifique, Quesneville. Vol. xiv., August, 1884.

Review of Chemical Researches Published Abroad.—M. G. de Bechi.—Abstracts from the *Berichte der Deut. Chem. Gesell.*

Quantitative Determination of Morphia in Opium.—Dr. von Perger.—From the *Journ. f. Prakt. Chemie.*

Tar and Ammonia.—An account of the attempts for utilising the by-products of the coke manufacture. The processes of Jameson, Simon-Carvès, Mellor, Davis, &c., are noticed, as also the criticisms of Weldon, Scheurer-Kestner, Forster, and Jameson.

Certain Recent Improvements in the Manufacture of Sugar.—E. G. von Lippmann.—The author particularly notices the method of Siegert, double or triple defecation alternating with filtration, which generally renders treatment with animal charcoal unnecessary.

Chemical Patents.—Abstracts of the specifications of a number of German patents relating to chemical manufactures.

Bulletin de la Société Chimique de Paris.
No. 12, June 20, 1884.

Crystalline Ammoniacal Silver Chloride and Ammoniacal Silver Iodide.—M. Terreil.—These compounds have hitherto been known only in the amorphous state. The author obtains them in crystals by introducing the amorphous compounds along with a saturated solution of ammonia into a flask sealed at the lamp and exposes the whole to the temperature of boiling water.

Constitution of Chloride of Lime.—E. Dreyfus.—The author, after reviewing the various hypotheses of Balard, Crace-Calvert, Fresenius, Lunge and Schäppi, Kolbe, Davis, and others, objects that not one of them gives a satisfactory explanation of the presence of an excess of hydrate of lime always observed in this compound. Stahlschmidt is the first who attained this object by representing the active principle of chloride of lime as hydrate of lime in which the hydrogen of one hydroxyl is replaced by chlorine. The author, with him, considers $CaHClO_2$ as the active principle of chloride of lime.

Revue Universelle des Mines, de la Metallurgie, &c.,
March and April, 1884.

This issue contains no chemical matter.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome xi., May, 1884.

This issue contains no chemical matter.

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Montreal Meeting, August 27, 1884.

INAUGURAL ADDRESS OF THE PRESIDENT,

The Right Hon. Lord Rayleigh, M.A., D.C.L., F.R.S., F.R.A.S., F.R.G.S., Professor of Experimental Physics in the University of Cambridge.

Ladies and Gentlemen,—It is no ordinary meeting of the British Association which I have now the honour of addressing. For more than fifty years the Association has held its Autumn gathering in various towns of the United Kingdom, and within those limits there is, I suppose, no place of importance which we have not visited. And now, not satisfied with past successes, we are seeking new worlds to conquer. When it was first proposed to visit Canada, there were some who viewed the project with hesitation. For my own part, I never quite understood the grounds of their apprehension. Perhaps they feared the thin edge of the wedge. When once the principle was admitted, there was no knowing to what it might lead. So rapid is the development of the British Empire, that the time might come when a visit to such out-of-the-way places as London or Manchester could no longer be claimed as a right, but only asked for as a concession to the susceptibilities of the English. But seriously, whatever objections may have at first been felt soon were outweighed by the consideration of the magnificent opportunities which your hospitality affords of extending the sphere of our influence and of becoming acquainted with a part of the Queen's dominion which, associated with splendid memories of the past, is advancing daily by leaps and bounds to a position of importance such as not long ago was scarcely dreamed of. For myself, I am not a stranger to your shores. I remember well the impression made upon me, seventeen years ago, by the wild rapids of the St. Lawrence, and the gloomy grandeur of the Saguenay. If anything impressed me more, it was the kindness with which I was received by yourselves, and which I doubt not will be again extended not merely to myself but to all the English members of the Association. I am confident that those who have made up their minds to cross the ocean will not repent their decision, and that apart altogether from scientific interests, great advantage may be expected from this visit. We Englishmen ought to know more than we do of matters relating to the Colonies, and anything which tends to bring the various parts of the Empire into closer contact can hardly be overvalued. It is pleasant to think that this Association is the means of furthering an object which should be dear to the hearts of all of us; and I venture to say that a large proportion of the visitors to this country will be astonished by what they see, and will carry home an impression which time will not readily efface.

To be connected with this meeting is, to me, a great honour, but also a great responsibility. In one respect, especially, I feel that the Association might have done well to choose another President. My own tastes have led me to study mathematics and physics rather than geology and biology, to which naturally more attention turns in a new country, presenting as it does a fresh field for investigation. A chronicle of achievements in these departments by workers from among yourselves would have been suitable to the occasion, but could not come from me. If you would have preferred a different subject for this address, I hope, at least, that you will not hold me entirely responsible.

At annual gatherings like ours the pleasure with which friends meet friends again is sadly marred by the absence of those who can never more take their part in our proceedings. Last year my predecessor in this office had to lament the untimely loss of Spottiswoode and Henry Smith, dear friends of many of us, and prominent members of our Association. And now, again, a well-known form is missing. For many years Sir W. Siemens has been a regular attendant at our meetings, and to few indeed have they been more indebted for success. Whatever the occasion, in his Presidential Address of two years ago, or in communications to the Physical and Mechanical Sections, he had always new and interesting ideas, put forward in language which a child could understand, so great a master was he of the of the art of lucid statement in his adopted tongue. Practice with Science was his motto. Deeply engaged in history, and conversant, all his life, with engineering operations, his opinion was never that of a mere theorist. On the other hand, he abhorred rule of thumb, striving always to master the scientific principles which underlie rational design and invention.

It is not necessary that I should review in detail the work of Siemens. The part which he took, during recent years, in the development of the dynamo machine must be known to many of you. We owe to him the practical adoption of the method, first suggested by Wheatstone, of throwing into a shunt the coils of the field magnets, by which a greatly improved steadiness of action is obtained. The same characteristics are observable throughout—a definite object in view and a well-directed perseverance in overcoming the difficulties by which the path is usually obstructed.

These are, indeed, the conditions of successful invention. The world knows little of such things, and regards the new machine or the new method as the immediate outcome of a happy idea. Probably, if the truth were known, we should see that, in nine cases out of ten, success depends as much upon good judgment and perseverance as upon fertility of imagination. The labours of our great inventors are not unappreciated, but I doubt whether we adequately realise the enormous obligations under which we lie. It is no exaggeration to say that the life of such a man as Siemens is spent in the public service; the advantages which he reaps for himself being as nothing in comparison with those which he confers upon the community at large.

As an example of this it will be sufficient to mention one of the most valuable achievements of his active life—his introduction, in conjunction with his brother, of the Regenerative Gas Furnace, by which an immense economy of fuel (estimated at millions of tons annually) has been effected in the manufacture of steel and glass. The nature of this economy is easily explained. Whatever may be the work to be done by the burning of fuel, a certain *temperature* is necessary. For example, no amount of heat in the form of boiling water would be of any avail for the fusion of steel. When the products of combustion are cooled down to the point in question, the heat which they still contain is useless as regards the purpose in view. The importance of this consideration depends entirely upon the working temperature. If the object be the evaporation of water or the warming of a house, almost all the heat may be extracted from the fuel without special arrangements. But it is otherwise when the temperature required is not much below that of combustion itself, for then the escaping gases carry away with them the larger part of the whole heat developed. It was to meet this difficulty that the regenerative furnace was devised. The products of combustion, before dismissal into the chimney, are caused to pass through piles of loosely stacked fire-

brick, to which they give up their heat. After a time the fire-brick, upon which the gases first impinge, becomes nearly as hot as the furnace itself. By suitable valves the burnt gases are then diverted through another stack of brickwork, which they heat up in like manner, while the heat stored up in the first stack is utilised to warm the unburnt gas and air on their way to the furnace. In this way almost all the heat developed at a high temperature during the combustion is made available for the work in hand.

As it is now several years since your presidential chair has been occupied by a professed physicist, it may naturally be expected that I should attempt some record of recent progress in that branch of science, if indeed such a term be applicable. For it is one of the difficulties of the task that subjects as distinct as Mechanics, Electricity, Heat, Optics, and Acoustics, to say nothing of Astronomy and Meteorology, are included under Physics. Any one of these may well occupy the life-long attention of a man of science, and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Not that I would complain of the association sanctioned by common parlance. A sound knowledge of at least the principles of general physics is necessary to the cultivation of any department. The predominance of the sense of sight as the medium of communication with the outer world, brings with it dependence upon the science of optics; and there is hardly a branch of science in which the effects of *temperature* have not (often without much success) to be reckoned with. Besides, the neglected borderland between two branches of knowledge is often that which best repays cultivation, or, to use a metaphor of Maxwell's, the greatest benefits may be derived from a cross fertilisation of the sciences. The wealth of material is an evil only from the point of view of one of whom too much may be expected. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards and borne much fruit upwards.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale—a subject to which I have already had occasion to allude in connection with the work of Sir W. Siemens. The dynamo machine is indeed founded upon discoveries of Faraday now more than half a century old; but it has required the protracted labours of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow. I do not refer to details of design, the elaboration of which must always, I suppose, require the experience of actual work to indicate what parts are structurally weaker than they should be, or are exposed to undue wear and tear. But with regard to the main features of the problem, it would almost seem as if the difficulty lay in want of faith. Long ago it was recognised that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power: and one cannot help thinking that if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious when regarded from the standpoint of accomplished fact; and I draw attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum—not more than about one-millionth of the normal quantity of air should remain—and it is interesting to recall that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial scale and entrusted to the hands of ordinary workmen.

When I speak in hopeful language of practical electricity, I do not forget the disappointment within the last year or two of many over-sanguine expectations. The enthusiasm of the inventor and promoter are necessary to progress, and it seems to be almost a law of nature that it should overpass the bounds marked out by reason and experience. What is most to be regretted is the advantage taken by speculators of the often uninstructed interest felt by the public in novel schemes by which its imagination is fired. But looking forward to the future of electric lighting, we have good ground for encouragement. Already the lighting of large passenger ships is an assured success, and one which will be highly appreciated by those travellers who have experienced the tedium of long winter evenings unrelieved by adequate illumination. Here, no doubt, the conditions are in many respects especially favourable. As regards space, life on board ship is highly concentrated; while unity of management and the presence on the spot of skilled engineers obviate some of the difficulties that are met with under other circumstances. At present we have no experience of a house-to-house system of illumination on a great scale and in competition with cheap gas; but preparations are already far advanced for trial on an adequate scale in London. In large institutions, such as theatres and factories, we all know that electricity is in successful and daily extending operation.

When the necessary power can be obtained from the fall of water, instead of from the combustion of coal, the conditions of the problem are far more favourable. Possibly the severity of your winters may prove an obstacle, but it is impossible to regard your splendid river without the thought arising that the day may come when the vast powers now running to waste shall be bent into your service. Such a project demands of course the most careful consideration, but it is one worthy of an intelligent and enterprising community.

The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which everything relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which cannot fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance, the resistance coils on which the electrician relies in dealing with currents whose maximum is a fraction of an ampere, fail altogether when it becomes a question of hundreds, not to say thousands, of amperes.

The powerful currents, which are now at command, constitute almost a new weapon in the hands of the physicist. Effects, which in old days were rare and difficult of observation, may now be produced at will on the most conspicuous scale. Consider for a moment Fara

day's great discovery of the "Magnetisation of Light," which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. This judgment (in which I fully concur) relates to the scientific aspect of the discovery, for to the eye of sense nothing could have been more insignificant. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarisation through 180° being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen in Germany, and H. Becquerel in France, have detected the rotation in gases and vapours, where, on account of its extreme smallness, it had previously escaped notice.

Again, the question of the magnetic saturation of iron has now an importance entirely beyond what it possessed at the time of Joule's early observations. Then it required special arrangements purposely contrived to bring it into prominence. Now in every dynamo machine, the iron of the field-magnets approaches a state of saturation, and the very elements of an explanation of the action require us to take the fact into account. It is indeed probable that a better knowledge of this subject might lead to improvements in the design of these machines.

Notwithstanding the important work of Rowland and Stoletow, the whole theory of the behaviour of soft iron under varying magnetic conditions is still somewhat obscure. Much may be hoped from the induction balance of Hughes, by which the marvellous powers of the telephone are applied to the discrimination of the properties of metals, as regards magnetism and electric conductivity.

The introduction of powerful alternate-current in machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known that when the changes are sufficiently rapid, the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle much may be explained that would otherwise seem paradoxical. To take a comparatively simple case, conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electro-motive force. If one wire only be used, a certain amount of heat is developed in the circuit. Suppose now that the second wire is brought into operation in parallel—a proceeding equivalent to doubling the section of the original wire. An electrician accustomed only to constant currents would be sure to think that the heating effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire. But such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire, and the total heating effect, so far from being doubled, would, in virtue of the superior conductivity, be halved.

During the last few years much interest has been felt in the reduction to an absolute standard of measurements of electro-motive force, current, resistance, &c., and to this end many laborious investigations have been undertaken. The subject is one that has engaged a good deal of my own attention, and I should naturally have felt inclined to dilate upon it, but that I feel it to be too abstruse and special to be dealt with in detail upon an occasion like the present. As regards resistance, I will merely remind you that the recent determinations have shown a so greatly improved agreement, that the Conference of Electricians assembled at Paris, in May, have felt themselves justified in defining the ohm for practical use as the resistance of a column of mercury of 0° C., one square millimetre in section, and 106 centimetres in length—a definition differing by a little more than one per cent. from that arrived at twenty years ago by a committee of this Association.

A standard of resistance once determined upon can be embodied in a "resistance coil," and copied without much trouble, and with great accuracy. But in order to complete the electrical system, a second standard of some kind is necessary, and this is not so easily embodied in a permanent form. It might conveniently consist of a standard galvanic cell, capable of being prepared in a definite manner, whose electro-motive force is once for all determined. Unfortunately, most of the batteries in ordinary use are for one reason or another unsuitable for this purpose, but the cell introduced by Mr. Latimer Clark, in which the metals are zinc in contact with saturated zinc sulphate and pure mercury in contact with mercurous sulphate, appears to give satisfactory results. According to my measurements, the electro-motive force of this cell is 1·435 theoretical volts.

We may also conveniently express the second absolute electrical measurement necessary to the completion of the system by taking advantage of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Professor Kohlrausch and by myself are in very good agreement, and the conclusion that one ampere flowing for one hour decomposes 4·025 grains of silver, can hardly be in error by more than a thousandth part. This number being known, the silver voltameter gives a ready and very accurate method of measuring currents of intensity, varying from 1·10th ampere to four or five amperes.

The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated and in some degree explained by De la Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters. In a recent research Crookes has sought the origin of a bright citron-coloured band in the phosphorescent spectrum of certain earths, and after encountering difficulties and anomalies of a most bewildering kind, has succeeded in proving that it is due to yttrium, an element much more widely distributed than had been supposed. A conclusion like this is stated in a few words, but those only who have undergone similar experience are likely to appreciate the skill and perseverance of which it is the final reward.

A remarkable observation by Hall of Baltimore, from which it appeared that the flow of electricity in a conducting sheet was disturbed by magnetic force, has been the subject of much discussion. Mr. Shelford Bidwell has brought forward experiments tending to prove that the effect is of a secondary character, due in the first instance to the mechanical force operating upon the conductor of an electric current when situated in a powerful magnetic field. Mr. Bidwell's view agrees in the main with Mr. Hall's division of the metals into two groups according to the direction of the effect.

Without doubt the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the Mechanical Theory of Heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics, and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule, has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science, and I think that the almost unavoidable use of the word equivalent in the statement of the first law is partly responsible or the little attention that is given to the second. For

the second law so far contradicts the usual statement of the first, as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose the work is worth the most, and when we speak of equivalents, we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides; the hotter the body in relation to its surroundings, the more available the heat.

In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam-engine. Not many years ago calculations were plentiful, demonstrating the inefficiency of the steam-engine on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and have very little bearing upon the practical question of efficiency, which requires us to have regard also to the second law. According to that law the fraction of the total energy which can be converted into work depends upon the relative temperatures of the boiler and condenser; and it is, therefore, manifest that, as the temperature of the boiler cannot be raised indefinitely, it is impossible to utilise all the energy which, according to the first law of thermo-dynamics, is resident in the coal.

On a sounder view of the matter, the efficiency of the steam-engine is found to be so high, that there is no great margin remaining for improvement. The higher initial temperature possible in the gas engine opens out much wider possibilities, and many good judges look forward to a time when the steam-engine will have to give way to its younger rival.

To return to the theoretical question, we may say with Sir W. Thomson, that though energy cannot be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognise its immense importance in the system of the universe. Every change—chemical, thermal, or mechanical—which takes place, or can take place, in nature does so, at the cost of a certain amount of available energy. If, therefore, we wish to inquire whether or not a proposed transformation can take place, the question to be considered is whether its occurrence would involve dissipation of energy. If not, the transformation is (under the circumstances of the case) absolutely excluded. Some years ago, in a lecture at the Royal Institution, I endeavoured to draw the attention of chemists to the importance of the principle of dissipation in relation to their science, pointing out the error of the usual assumption that a general criterion is to be found in respect of the development of heat. For example, the solution of a salt in water is, if I may be allowed the phrase, a downhill transformation. It involves dissipation of energy, and can therefore go forward; but in many cases it is associated with the absorption rather than with the development of heat. I am glad to take advantage of the present opportunity in order to repeat my recommendation, with an emphasis justified by actual achievement. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labours of several physicists, among whom must be especially mentioned Willard Gibbs and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and we cannot doubt far-reaching in its consequences. In a series of masterly papers Helmholtz has developed the conception of *free energy* with very important applications to the theory of the galvanic cell. He points out that the mere tendency to solution bears in some cases no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electro-motive force. Also in our own country Dr. Alder Wright has published some valuable experiments relating to the subject.

From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings towards a first love may blind me, but I cannot help thinking that the next great advance, of which we have already some foreshadowing, will come on this side. And if I might without presumption venture a word of recommendation, it would be in favour of a more minute study of the simpler chemical phenomena.

Under the head of scientific mechanics it is principally in relation to fluid motion that advances may be looked for. In speaking upon this subject I must limit myself almost entirely to experimental work. Theoretical hydrodynamics, however important and interesting to the mathematician, are eminently unsuited to oral exposition. All I can do to attenuate an injustice, to which theorists are pretty well accustomed, is to refer you to the admirable reports of Mr. Hicks, published under the auspices of this Association.

The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is doubtless known to most of you. Recognising the fallacy of views then widely held as to the nature of the resistance to be overcome, he showed to demonstration that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin friction, and at high speeds upon the generation of surface waves by which energy is carried off. At speeds which are moderate in relation to the size of the ship, the resistance is practically dependent upon skin friction only. Although Professor Stokes and other mathematicians had previously published calculations pointing to the same conclution, there can be no doubt that the view generally entertained was very different. At the first meeting of the Association which I ever attended, as an intelligent listener, at Bath in 1864, I well remember the surprise which greeted a statement by Rankine that he regarded skin friction as the only legitimate resistance to the progress of a well-designed ship. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision.

In speaking of an explanation as satisfactory in which skin friction is accepted as the cause of resistance, I must guard myself against being supposed to mean that the nature of skin friction is itself well understood. Although its magnitude varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure.

Some important work bearing upon the subject has recently been published by Professor O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion and upon the size of the bore. The laws of motion in capillary tubes, discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin friction in relation to ship propulsion. Professor Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability under these complicated conditions of the general laws of dynamical similarity as adapted to viscous fluids by Professor Stokes. In spite of the difficulties which beset both the theoretical

and experimental treatment, we may hope to attain before long to a better understanding of a subject which is certainly second to none in scientific as well as practical interest.

As also closely connected with the mechanics of viscous fluids, I must not forget to mention an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of Mechanical Engineers. The results go far towards upsetting some ideas hitherto widely admitted. When the lubrication is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as 1-1000th. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid, and the work lost is spent in shearing, that is, in causing one stratum of the oil to glide over another.

In order to maintain its position, the fluid must possess a certain degree of viscosity, proportionate to the pressure; and even when this condition is satisfied, it would appear to be necessary that the layer should be thicker on the ingoing than on the outgoing side. We may, I believe, expect from Professor Stokes a further elucidation of the processes involved. In the meantime, it is obvious that the results already obtained are of the utmost value, and fully justify the action of the Institution in devoting a part of its resources to experimental work. We may hope indeed that the example thus wisely set may be followed by other public bodies associated with various departments of industry.

I can do little more than refer to the interesting observations of Professor Darwin, Mr. Hunt, and M. Forel on Ripplemark. The processes concerned would seem to be of a rather intricate character, and largely dependent upon fluid viscocity. It may be noted indeed that most of the still obscure phenomena of hydro-dynamics require for their elucidation a better comprehension of the laws of viscous motion. The subject is one which offers peculiar difficulties. In some problems in which I have lately been interested, a circulating motion presents itself of the kind which the mathematician excludes from the first when he is treating of fluids destitute altogether of viscosity. The intensity of this motion proves, however, to be independent of the coefficient of viscosity so that it cannot be correctly dismissed from consideration as a consequence of a supposition that the viscosity, is infinitely small. The apparent breach of continuity can be explained, but it shows how much care is needful in dealing with the subject, and how easy it is to fall into error.

The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disc moving in its own plane between two parallel solid surfaces is impeded by the necessity of shearing the intervening layers of gas, and the magnitude of the hindrance is proportional to the velocity of the motion and to the viscosity of the gas, so that under similar circumstances this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drow the startling conclusion that the viscosity of a gas should be independent of its density—that within wide limits the resistance to the moving disc should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation—one of the most remarkable to be found in the whole history of science, and proved that the swinging disc was retarded by the gas, as much when the barometer stood at half an inch as when it stood at thirty inches. It was obvious, of course, that the law must have a limit, that at a certain point of exhaustion the gas must begin to lose its power; and I remember discussing with Maxwell, soon after the publication of his experiments, the whereabouts of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion, and the failure of the law was first observed by Kundt and Warburg, as pressures below 1 m.m. of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion as measured by McLeod's guage. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of 760 m.m. down to about $\frac{1}{2}$ m.m. of mercury the viscosity is sensibly constant. From this point to the highest vacua, in which less than one-millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value. In these vacua Mr. Crookes regards the gas as having assumed a different, ultra-gaseous, condition; but we must remember that the phenomena have relation to the other circumstances of the case, especially the dimensions of the vessel, as well as to the condition of the gas.

Such an achievement as the prediction of Maxwell's law of vicosity has, of course, drawn increased attention to the dynamical theory of gases. The success which has attended the theory in the hands of Clausius, Maxwell, Boltzman, and other mathematicians, not only in relation to vicosity, but over a large part of the entire field of our knowledge of gases, proves that some of its fundamental postulates are in harmony with the reality of Nature. At the same time, it presents serious difficulties; and we cannot but feel that while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible. The growth of experimental knowledge may be trusted to clear up many doubtful points, and a younger generation of theorists will bring to bear improved mathematical weapons. In the meantime we may fairly congratulate ourselves on the possession of a guide which has already conducted us to a position which could hardly otherwise have been attained.

In Optics attention has naturally centred upon the spectrum. The mystery attaching to the invisible rays lying beyond the red has been fathomed to an extent that, a few years ago, would have seemed almost impossible. By the use of special photographic methods Abney has mapped out the peculiarities of this region with such success that our knowledge of it begins to be comparable with that of the parts visible to the eye. Equally important work has been done by Langley, using a refined invention of his own based upon the principle of Siemens's pyrometer. This instrument measures the actual energy of the radiation, and thus expresses the effects of various parts of the spectrum upon a common scale, independent of the properties of the eye and of sensitive photographic preparations. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint. It would be interesting to compare the experimental numbers with the law of scattering of light by small particles given some years ago as the result of theory. The demonstration by Langley of the inadequacy of Cauchy's law of dispersion to represent the relation between refrangibility and wavelength in the lower part of the spectrum must have an important bearing upon optical theory.

The investigation of the relation of the visible and ultra-violet spectrum to various forms of matter has occupied the attention of a host of able workers, among whom none have been more successful than my colleagues at Cambridge, Professors Liveing and Dewar. The subject is too large both for the occasion and for the individual, and I must pass it by. But, as more relating to Optics proper, I cannot resist recalling to your notice a beautiful

application of the idea of Doppler to the discrimination of the origin of certain lines observed in the solar spectrum. If a vibrating body have a general motion of approach or recession, the waves emitted from it reach the observer with a frequency which in the first case exceeds, and in the second case falls short of, the real frequency of the vibrations themselves. The consequence is that, if a glowing gas be in motion in the line of sight, the spectral lines are thereby displaced from the position that they would occupy were the gas at rest—a principle which, in the hands of Huggins and others, has led to a determination of the motion of certain fixed stars relatively to the solar system. But the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb. This displacement was, I believe, first observed by Thollon; but what I desire now to draw attention to is the application of it by Cornu to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. Under these circumstances a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds, and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope. In this way Cornu was able to make a discrimination which can only otherwise be effected by a difficult comparison of appearances under various solar altitudes.

The instrumental weapon of investigation, the spectroscope itself, has made important advances. On the theoretical side, we have for our guidance the law that the optical power in gratings is proportional to the total number of lines accurately ruled, without regard to the degree of closeness, and in prisms that it is proportional to the thickness of glass traversed. The magnificent gratings of Rowland are a new power in the hands of the spectroscopist, and as triumphs of mechanical art seem to be little short of perfection. In our own report for 1882, Mr. Mallock has described a machine, constructed by him, for ruling large diffraction gratings, similar in some respects to that of Rowland.

The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the toothed wheel, Young and Forbes drew the conclusion that the velocity of light *in vacuo* varies from colour to colour, to such an extent that the velocity of blue light is nearly two per cent greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method (that of Foucault) is well suited to bring into prominence a variation of velocity with wave-length, informs me that he has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists comparable with that asserted by Young and Forbes. The actual velocity differs little from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second.

It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. The top is, or may be understood, but a complete comprehension of the kite and of the soap-bubble would carry us far beyond our present stage of knowledge. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of colour was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. In accordance with this view the tint is determined solely by the thickness of the film, and the refractive index of the fluid. Some of the phenomena are however so curious, as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of colouring matter. If the rim of a wine-glass be dipped in soapy water, and then held in a vertical position, horizontal bands soon begin to show at the top of the film, and extend themselves gradually, downwards. According to Brewster these bands are not formed by the "subsidence and gradual thinning of the film," because they maintain their horizontal position when the glass is turned round its axis. The experiment is both easy and interesting; but the conclusion drawn from it cannot be accepted. The fact is that the various parts of the film cannot quickly alter their thickness, and hence when the glass is rotated they rearrange themselves in order of superficial density, the thinner parts floating up over, or through, the thicker parts. Only thus can the tendency be satisfied for the centre of gravity to assume the lowest possible position.

When the thickness of a film falls below a small fraction of the length of a wave of light, the colour disappears and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the coloured portions being exceedingly abrupt. By two independent methods they have determined the thickness of the black film to lie between seven and fourteenth millionths of a milimetre; so that the thinnest films correspond to about one-seventieth of a wave-length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

The beautiful inventions of the telephone and the phonograph, although in the main dependent upon principles long since established, have imparted a new interest to the study of Acoustics. The former, apart from its uses in every day life, has become in the hands of its inventor, Graham Bell, and of Hughes, an instrument of first-class scientific importance. The theory of its action is still in some respects obscure, as is shown by the comparative failure of the many attempts to improve it. In connection with some explanations that have been offered, we do well to remember that molecular changes in solid masses are inaudible in themselves, and can only be manifested to our ears by the generation of a to and fro motion of the external surface extending over a sensible area. If the surface of a solid remains undisturbed, our ears can tell us nothing of what goes on in the interior.

In theoretical acoustics progress has been steadily maintained, and many phenomena, which were obscure twenty or thirty years ago, have since received adequate explanation. If some important practical questions remain unsolved, one reason is that they have not yet been definitely stated. Almost everything in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings, that they have learned to interpret indications which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognising, without much difficulty, the quarter from which a sound proceeds, but by what steps we attain that end has not yet been satisfactorily explained. It has been proved that when proper precautions are taken we are unable to distinguish whether a pure tone (as from a vibrating tuning fork held over a suitable resonator) comes to us from in front or from behind. This is what might have been expected from an *à priori* point of view; but what would not have been expected is

that with almost any other sort of sound, from a clap of the hands to the clearest vowel sound, the discrimination is not only possible but easy and instinctive. In these cases it does not appear how the possession of two ears helps us, though there is some evidence that it does; and even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned towards than with the ear that is turned from it, and that in this way the direction was recognised. But if we try the experiment, we find that at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough in relation to the dimensions of the head to forbid the formation of anything like a sound shadow in which the averted ear might be sheltered.

In concluding this imperfect survey of recent progress in physics, I must warn you emphatically that much of great importance has been passed over altogether. I should have liked to speak to you of those far reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electromagnetic medium. Indeed, at one time, I had thought of taking the scientific work of Maxwell as the principal theme of this address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment, and thus much of his work could hardly be considered upon such an occasion as the present. His biography has recently been published, and should be read by all who are interested in science and in scientific men. His many-sided character, the quaintness of his humour, the penetration of his intellect, his simple but deep religious feeling, the affection between son and father, the devotion of husband to wife, all combine to form a rare and fascinating picture. To estimate rightly his influence upon the present state of science, we must regard not only the work that he executed himself, important as that was, but also the ideas and the spirit which he communicated to others. Speaking for myself as one who in a special sense entered into his labours, I should find it difficult to express adequately my feeling of obligation. The impress of his thoughts may be recognised in much of the best work of the present time. As a teacher and examiner he was well acquainted with the almost universal tendency of uninstructed minds to elevate phrases above things: to refer, for example, to the principle of the conservation of energy for an explanation of the persistent rotation of a fly-wheel, almost in the style of the doctor in "Le Malade Imaginaire," who explains the fact that opium sends you to sleep by its soporific virtue. Maxwell's endeavour was always to keep the facts in the foreground, and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypothesis which is one of the distinguishing characteristics of the science of the present day.

In speaking unfavourably of superfluous hypothesis, let me not be misunderstood. Science is nothing without generalisations. Detached and ill-assorted facts are only raw material, and in the absence of a theoretical solvent, have but little nutritive value. At the present time and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as "known," and it is often forgotten that the re-discovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well-nigh hopeless. Much useful work has been done in this direction in connection with our Association. Such critical reports as those upon Hydro-dynamics, upon Tides, and upon Spectroscopy guide the investigator to the points most requiring attention, and in discussing past achievements contribute in no small degree to future progress. But though good work has been done, much yet remains to do.

If, as is sometimes supposed, science consisted in nothing but the laborious accumulation of facts, it would soon come to a stand-still, crushed, as it were, under its own weight. The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence facilitates the retention of the remainder in an available form. Those who are acquainted with the writings of the older electricians will understand my meaning when I instance the discovery of Ohm's law as a step by which the science was rendered easier to understand and to remember. Two processes are thus at work side by side, the reception of new material and the digestion and assimilation of the old; and as both are essential, we may spare ourselves the discussion of their relative importance. One remark, however, should be made. The work which deserves, but I am afraid does not always receive, the most credit is that in which discovery and explanation go hand in hand, in which not only are new facts presented, but their relation to old ones is pointed out.

In making oneself acquainted with what has been done in any subject, it is good policy to consult first the writers of highest general reputation. Although in scientific matters we should aim at independent judgment, and not rely too much upon authority, it remains true that a good deal must often be taken upon trust. Occasionally an observation is so simple and easily repeated, that it scarcely matters from whom it proceeds; but as a rule it can hardly carry full weight when put forward by a novice whose care and judgment there has been no opportunity of testing, and whose irresponsibility may tempt him to "take shots," as it is called. Those who have had experience in accurate work know how easy it would be to save time and trouble by omitting precautions and passing over discrepancies, and yet, even without dishonest intention, to convey the impression of conscientious attention to details. Although the most careful and experienced cannot hope to escape occasional mistakes, the effective value of this kind of work depends much upon the reputation of the individual responsible for it.

In estimating the present position and prospects of experimental science, there is good ground for encouragement. The multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances when he knows that by other means a better result could be attained with greater facility. Nevertheless it seems to me important to discourage too great reliance upon the instrument maker. Much of the best original work has been done with the homeliest appliances; and the endeavour to turn to the best account the means that may be at hand develops ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger otherwise that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid.

From the general spread of a more scientific education, we are warranted in expecting important results. Just as there are some brilliant literary men with an inability, or at least a distaste practically amounting to inability, for scientific ideas, so there are a few with scientific tastes

whose imaginations are never touched by merely literary studies. To save these from intellectual stagnation during several important years of their lives is something gained; but the thorough-going advocates of scientific education aim at much more. To them it appears strange, and almost monstrous, that the dead languages should hold the place they do in general education; and it can hardly be denied that their supremacy is the result of routine rather than of argument. I do not, myself, take up the extreme position. I doubt whether an exclusively scientific training would be satisfactory; and where there is plenty of time and a literary aptitude I can believe that Latin and Greek may make a good foundation. But it is useless to discuss the question upon the supposition that the majority of boys attain either to a knowledge of the languages or to an appreciation of the writings of the ancient authors. The contrary is notoriously the truth; and the defenders of the existing system usually take their stand upon the excellence of its discipline. From this point of view there is something to be said. The laziest boy must exert himself a little in puzzling out a sentence with grammar and dictionary, while instruction and supervision are easy to organise and not too costly. But when the case is stated plainly, few will agree that we can afford so entirely to disregard results. In after life the intellectual energies are usually engrossed with business, and no further opportunity is found for attacking the difficulties which block the gateways of knowledge. Mathematics, especially, if not learned young, are likely to remain unlearned. I will not further insist upon the educational importance of mathematics and science, because with respect to them I shall probably be supposed to be prejudiced. But of modern languages I am ignorant enough to give value to my advocacy. I believe that French and German, if properly taught, which I admit they rarely are at present, would go far to replace Latin and Greek from a disciplinary point of view, while the actual value of the acquisition would, in the majority of cases, be incomparably greater. In half the time usually devoted, without success, to the classical languages, most boys could acquire a really serviceable knowledge of French and German. History and the serious study of English literature, now shamefully neglected, would also find a place in such a scheme.

There is one objection often felt to a modernised education, as to which a word may not be without use. Many excellent people are afraid of science as tending towards materialism. That such apprehension should exist is not surprising, for unfortunately there are writers, speaking in the name of science, who have set themselves to foster it. It is true that among scientific men, as in other classes, crude views are to be met with as to the deeper things of Nature; but that the life-long beliefs of Newton, of Faraday, and of Maxwell are inconsistent with the scientific habit of mind, is surely a proposition which I need not pause to refute. It would be easy, however, to lay too much stress upon the opinions of even such distinguished workers as these. Men who devote their lives to investigation cultivate a love of truth for its own sake, and endeavour instinctively to clear up, and not, as is too often the object in business and politics, to obscure a difficult question. So far the opinion of a scientific worker may have a special value; but I do not think that he has a claim, superior to that of other educated men, to assume the attitude of a prophet. In his heart he knows that underneath the theories that he constructs there lie contradictions which he cannot reconcile. The higher mysteries of being, if penetrable at all by human intellect, require other weapons than those of calculation and experiment.

Without encroaching upon grounds appertaining to the theologian and the philosopher, the domain of natural science is surely broad enough to satisfy the wildest ambition of its devotees. In other departments of human life and interest, true progress is rather an article of faith than a rational belief; but in science a retrograde movement is, from the nature of the case, almost impossible. Increasing knowledge brings with it increasing power, and great as are the triumphs of the present century, we may well believe that they are but a foretaste of what discovery and invention have yet in store for mankind. Encouraged by the thought that our labours cannot be thrown away, let us redouble our efforts in the noble struggle. In the Old World and in the New, recruits must be enlisted to fill the place of those whose work is done. Happy should I be if, through this visit of the Association, or by any words of mine, a larger measure of the youthful activity of the West could be drawn into this service. The work may be hard, and the discipline severe; but the interest never fails, and great is the privilege of achievement.

RECENT ESTIMATIONS OF THE AMOUNT OF SALICYLIC ACID IN THE CULTIVATED PANSY.

By Dr. A. B. GRIFFITHS, F.C.S. (London and Paris), Lecturer on Metallurgy, City of London College, &c.; and

E. C. CONRAD, F.C.S. (London and Paris), Manager and Chemist to Betts and Co.'s Works, Bordeaux, &c.

Salicylic acid ($C_7H_6O_3$) was first discovered as a product of plant-life in certain plants by Piria, in 1838. In 1844 Gerhardt and Cahours obtained it from *Gaultheria procumbens* (Winter green), and Professor K. Mandelin has discovered salicylic acid or acids of the $C_nH_{2n-8}O_3$ series in the different varieties of violets and the Violaceæ generally.

Recently we have determined the amount of salicylic acid in the garden pansy with the following results:—

	I..	II.
The leaves yielded, per cent,	0·1329	0·1330
The stems ,, ,,	0·0852	0·0856
The roots ,, ,,	0·0531	0·0529

While the flowers gave evidence of only a trace of this acid. From these analyses it will be seen that the leaves of the plant contain the largest amount of this acid, and the flowers the smallest. We cut several thin sections of the leaves, stem, and root, and examined them under the highest powers of the microscope, but were unable to discover any crystals of salicylic acid in the cells, &c., of the plant, whence we conclude that it is dissolved in the cell-sap, or perhaps the protoplasm itself.

What the physiological functions of this organic acid are as regards the life of the plant we are at present unable to say, nor are we able to state how this salicylic acid is formed in the plant.

REACTIONS OF QUININE, NARCOTINE, AND MORPHINE WITH BROMINE.

By ARNOLD EILOART, B.Sc.

Quininè.—Professor Vogel's red colour obtained by successive addition of bromine water, potassium ferrocyanide, and borax (*Anal. Zeits.*, xxiii., p. 78) shows 1-60,000th part of quinine. Substitution of mercuric cyanide for the ferrocyanide, and of precipitated chalk for the borax extends the limit to 1-500,000th. With petroleum spirit instead of mercuric cyanide the limit is 1-50,000th; no debrominating agent being used, the crimson* appears with *weak* ammonia, or other neutralising agent, *e.g.*, zinc oxide, but the limit is then (with chalk) 1-15,000th only.

* Attempts to isolate the red body failed; dry quinine does not give it with dry bromine vapour, but takes up bromine and is coloured orange; addition of water then gives the crimson, but not if free bromine is first removed.

The rose-pink obtained by Professor Bloxam (CHEMICAL NEWS, xlvii., p. 215) by boiling with bromine water, shows 1-15,000th part in acid solutions of quinine; addition of chalk before the bromine extends the limit to 1-50,000th; a strong solution will then become violet in the cold, changing to blue when heated, and becoming again violet with more bromine.

When a neutral solution of quinine is mixed with bromine in excess, boiled till after the excess is expelled, and cooled, a beautiful green fluorescence appears when the solution contains 1-50,000th of quinine.

Narcotine.—If narcotine be dissolved in HCl, and bromine added in slight excess, the liquid becomes red when neutralised with calcium carbonate; if the solution contains more than 1-1000th of narcotine, the red colour is followed by violet and blue. This is the case even when the solution is set aside for some time after adding the bromine, whereas a brominated solution of quinine gives no colour with chalk if allowed to stand. One part of narcotine in 6000th will give a red colour in this way. The colour is less in presence of tartaric or of acetic acid.

Morphine.—When a solution containing morphine is boiled with excess of bromine water, neutralised with chalk, and again boiled, a bright red colour appears if the solution contain more than 1-1200th part of morphine. With less than this the colour is orange or brown, and is bleached by more bromine water. By dividing the neutralised solution, and adding a drop of bromine to one part, the bleaching was perceptible when only 1-120,000th part of morphine was present.

Strychnine, *cinchonine*, and *caffeine* gave no characteristic reaction with bromine and chalk.

DETERMINATION OF NITRIC ACID BY PRECIPITATION AS CINCHONAMINE NITRATE. APPLICATION OF THIS PROCESS TO THE DETERMINATION OF THE NITRATES CONTAINED IN NATURAL WATERS AND IN PLANTS.

By M. ARNAUD.

CINCHONAMINE nitrate is almost insoluble in water acidfied with from 10 to 15 per cent of hydrochloric acid. It is therefore very easy to detect the nitrates qualitatively by bringing the solution to this condition. But for an exact determination it is impossible to employ this means, as, in drying, the acid becomes concentrated, and finally attacks not only the paper of the filter but the cinchonamine nitrate itself.

After many attempts the author has succeeded in obtaining very good results by operating as follows:—

The liquid containing the nitrates is neutralised with soda if acid, and with sulphuric acid if alkaline, the essential point being to obtain neutrality. The chlorine of the chlorides, if any are present, is eliminated with silver acetate, any excess of the latter being removed by the addition of a few drops of sodium phosphate. The filtrate is then evaporated almost to dryness and filtered anew if it is not absolutely clear, acidulated very slightly with a drop of dilute acetic acid. The liquid is then precipitated at a boil with a hot solution of cinchonamine sulphate. Cinchonamine nitrate falls down immediately in a crystalline state. It is let stand for twelve hours in a cool place. It is then brought upon a filter and washed with an aqueous solution of cinchonamine nitrate, saturated at the temperature of the atmosphere so as to remove any cinchonamine sulphate.

The object of this method of washing is to avoid dissolving any trace of the cinchonamine nitrate, however slight. Pure water, employed instead, would dissolve about 2-1000th of its weight of the cinchonamine nitrate. The precipitate is dried at 100° and weighed, being perfectly pure.

Cinchonamine nitrate has the formula,—

$$C_{19}H_{24}N_2O,NO_3H.$$

Its high molecular weight is advantageous for the determination of nitric acid, as 359 parts cinchonamine nitrate represent 54 parts nitric acid, 101 potassium nitrate, or 82 parts calcium nitrate.

In this manner the author has determined the nitric acid contained in natural waters in the state of nitrates, probably as calcium nitrate, and has obtained at different times perfectly accordant results. For well-waters he evaporates 1 litre of the sample to dryness, takes up the residue in alcohol at 40° per cent, and expels the alcohol by evaporation in the water-bath. The aqueous solution resulting from this treatment contains all the nitrates as well as a certain quantity of chlorides. The analysis is continued as indicated above.

For determining the nitrates contained in plants the procedure is slightly modified. The plant is triturated and exhausted with boiling water. The liquid is evaporated to the consistence of an extract and re-dissolved in alcohol at 40 per cent. The alcohol is expelled by evaporation on the water-bath, and in the liquid resulting the chlorides are eliminated by the addition of a small quantity of neutral lead acetate, any small excess of which is removed by means of a few drops of sodium sulphate. In the filtrate the nitrates are determined as above.—*Comptes Rendus.*

NOTICES OF BOOKS.

Report of the Metropolitan Board of Works, 1883.

VERY much of the matter contained in this report is not of a nature which can fitly come under our notice. There is a section on "Sewerage and Drainage" but it deals merely with the construction of sewers and does not enter upon the purification of the sewage. The "State of the Thames" is briefly referred to. We are told that the Board denies the charges brought concerning the pollution of the river. Hence it would appear that this important body is still satisfied with the method which it has adopted for dealing with the sewage of the metropolis.

As regards the gas supply we notice a curious concession to the Companies. Sulphur, during the months from April to October, 1883, was allowed to the extent of 17 grains in 100 feet. "From October till next April (1884) the maximum is to be 22 grains." Why the standard of purity should thus be reduced it is not easy to see.

The electric light is very briefly touched upon. There is a complaint that on the Victoria Embankment and on Waterloo Bridge, which were lighted by the Jablochkoff Electric Light and Power Company, "the Board has on several occasions lately had to complain of the sudden extinction of many of the lights during the hours when the company is bound by the agreement to keep them shining."

The notice of the water supply, though expressing dissatisfaction with existing arrangements, raises no question concerning the purity of the water.

It appears that 2718 diseased animals have been killed during the year in the Metropolitan district, under the provisions of the "Contagious Diseases Act." An alarming fact is that persons still drive or lead glandered or farcied horses through the streets, to the public danger. Ten persons have been convicted of this offence, and penalties varying from 5s. (!) to £10 were imposed. As the result of this negligence may be to infect any passer-by with a loathsome and incurable disease, it seems that such penalties do not err on the side of severity.

Oxidation of Mercury Diethyl with Potassium Permanganate.—M. Seidl.—The result of the reaction is ethyl-mercuric chloride.—*Journ. f. Prakt. Chemie.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Justus Liebig's Annalen der Chemie,
Vol. 223, Part 3.

Communications from the Laboratory of the Technical High School of Stuttgart on Examinations of Wax.—These consist of a memoir by Carl Hell on a method for determining the molecular weight and the atomicity of the higher fatty alcohols; and a paper by H. Stürke on the chemical constituents of carnauba wax. This compound contains a hydrocarbon melting at 59° to 59·5, an alcohol, $C_{26}H_{53}CH_2OH$, melting at 76°, myricylic alcohol, a bi-acid alcohol melting at 103·5°, an acid, $C_{23}H_{47}COOH$, isomeric with lignoceric acid, and melting at 72·5°, an acid, $C_{26}H_{53}COOH$, identical or isomeric with cerotic acid, and an oxy acid melting at 103·5°.

Some Reactions of Iodine upon Organic Compounds at Elevated Temperatures. — Bohuslaw Ráyman and Karl Preis.—At 250° alcohol acts upon aromatic compounds in such a manner that the lateral catenæ are separated and broken up into methyls, which latter then enter the nucleus as substituents.

On Tin Bromides.—B. Ráyman and Karl Preis.—The authors have examined tin dibromide, a crystalline, faintly yellowish, translucent mass, fusible at 215·5°, specific gravity 5·117. It is partially decomposed by water, forming a white oxy-bromide. The aqueous dibromide formed by the action of warm hydrobromic acid upon metallic tin forms colourless acicular or thin prismatic crystals, which form a turbid solution in water. Tin tetra-bromide is a white substance of nacreous lustre. When melted it very readily dissolves iodine and sulphur. The tetra-bromide dissolves in cold water without decomposition, but on heating, stannic acid is separated out. Heated tetra-bromide absorbs ammonia energetically, and is converted into a white mass, $SnBr_42NH_3$,. Tin bromide hydrobromate was obtained during the action of tin tetrabromide and bromine upon alcohols. The authors describe its sodium, calcium, strontium, magnesium, manganese, iron, nickel, and cobalt salts. They have also studied the oxy-bromides.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir on the polysulphides of sodium, by Dr. H. Böttger; three others, by the same author respectively on the constitution of the alkaline polysulphides, on the action of sulphur upon sodium mercaptide, and on sulphethyl; a paper by Dr. Hugo Prinz on the constitution of sulphur chloride, and one by the same author on experiments on combining sulphur with sulphur. The result reached in this last paper is that no such combination is formed by the reciprocal action of compounds from which such a result might be expected, but that the sulphur oxy-chlorides are so decomposed in contact with other sulphur compounds as if the residue, SCl_4, was contained in them.

Journal für Praktische Chemie.
New Series, Vol. xxix., Part 3.

Quantitative Determination of Morphine in Opium.—H. von Perger.—This paper will be inserted at length.

Studies on Milk.—H. Struve.—A series of investigations on human milk.

On so-called Rubean-Hydrogen.—R. Wollner.—The compound in question, $C_2N_2H_4S_2$, is formed by passing dry cyanogen gas into an alcoholic solution of sodium sulphhydrate. The author considers that this compound is a derivative of a still unknown compound—thio-oxalic acid.

A Pneumatic Trough without a Shelf and with freely-suspended Cylinders.—Dr. F. Gottschalk.—This apparatus cannot be described intelligibly without the accompanying diagram.

Oxy-base of Cyan-methine, $C_6H_8N_2O$.—R. Wollner.—This base is obtained by the action of nitrous acid upon cyan-methine in an acetic solution when hydroxyl is substituted for the amide.

Action of Potassium Permanganate upon Mercury Diphenyl.—Robert Otto.—A correction of a statement made by the author in the *Annalen der Chemie und Pharmacie*, 154, p. 93.

Trichlor-methyl-sulphon Chloride.—G. McGowan.—In this preliminary communication the author announces that he is examining in what manner the nature of the compounds in question is affected by the introduction of one or more atoms of chlorine. Methyl-sulphon chloride yields with ammonia the amide, and with aniline the anilide of methyl-sulphonic acid.

Remarks on the Chemical Constitution of Anthraquinone, Anthracene, and accompanying Compounds.—E. von Meyer.—The author regards anthraquinone not as a diketone, but as a derivation of phthalide. Numerous experimental facts concerning anthraquinone are in perfect harmony with the view that anthraquinone is an orthophenylen-phthalide, in which orthophenylen takes the place of two atoms hydrogen of the phthalide.

Vol. xxix., Parts 4 and 5.

Action of Reducing Agents upon Ortho-nitro-phenoxyl-acetic Acid.—Alexander Thate.—The best method for preparing ortho-nitro-phenoxyl-acetic acid is to heat equivalent quantities of ortho-nitro-phenol sodium and sodium mono-chloracetate to 100° for 10 to 12 hours in a concentrated aqueous solution. By the reduction of ortho-nitro-phenoxyl-acetic acid in an alkaline solution by means of sodium amalgam, there are obtained in succession azoxy-ortho-phenoxyl-acetic acid, azortho-phenyl-oxyl-acetic acid, hydrazo-ortho-phenoxyl-acetic acid, and ortho-amido-phenoxyl acetic acid. By the reduction of ortho-nitro-phenoxyl-acetic acid with iron-filings and acetic acid, it is easy to obtain ortho-amido-phenoxyl-acetic anhydride, but not the azo-compounds derivable from ortho-nitro-phenoxyl-acetic acid. By the reduction of ortho-nitro-phenoxyl-acetic acid with stannous chloride in a hydrochloric solution, there is formed, firstly mono-chlor-ortho-amido-phenoxyl-acetic anhydride, and along with it, especially if the reduction is imperfect, ortho-amido-phenoxyl-acetic anhydride.

A Uranium Mineral from Moss, and on Naturally-occurring Uranates in General.—C. W. Blomstrand.—The mineral in question is found in the felspar quarries, near Moss, on the eastern side of the Christianiafjord. It contains nearly 81 per cent of uranoso-uranic oxide, along with 0·38 of the cerium earths, and 2·42 of the yttrium earths.

Electrolyses and Electro-syntheses.—E. Drechsel.—The author has studied electrolyses with alternating currents, employing electrodes of different metals, and the electro-synthesis of sulpho-phenol ether. The products obtained are in part the same as those formed in the animal body from phenol, the ether-sulphacids of phenol, hydroquinone, and pyrocatechin.

Letter of a Young Chemist to the Editor of the Journal.—An anonymous letter, in which the writer describes his conversion from the structural views of Beyer. He says, "Rau's work ("The Theories of Modern Chemistry") has changed me from a chemical Saul to a chemical Paul. There remains for me now the task of completely freeing myself from the chains of modern structural chemistry, and of becoming, as I have resolved, a zealous disciple of classical chemistry as planned by Berzelius, developed by Gay-Lussac, Graham, Liebig.

Wöhler, Bunsen, &c., and which will again become dominant in an early future."

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 1, July 5, 1884.

On certain Double Tungstates of Sodium and of the Metals of the Rare Earths.—M. A. Högbom.—The author has prepared these salts by dissolving the oxides in question and tungstic acid in melting sodium tungstate, or common salt, or in a mixture of both. All the salts described are insoluble in water. Acids attack them in the cold after some time. Hydrochloric acid, if concentrated, decomposes them perfectly. The author has obtained and examined the double tungstates of sodium and didymium, of sodium and yttrium, of sodium and cerium, of sodium and samarium, of sodium and erbium, and of sodium and thorium. M. Cleve remarks in a note, "It is very remarkable that all these double salts, in spite of their different compositions, crystallise in the same forms or in the form of scheelite; this latter mineral is also isomorphous with fergusonite.

No. 2, 1884.

The Decomposition of Sulphonic Acids by means of Hydrated Sulphuric Acid.—C. Friedel and J. M. Crafts.—The sulphonic acid, or one of its salts, is mixed with three or four times its weight of sulphuric acid diluted with about one-third its weight of water; a thermometer is placed in the liquid; a current of steam passed into the mixture, which is then heated in a retort up to the point at once the hydrocarbon begins to separate. The decomposition is rapid about 160°, and the temperature may be raised up to 175° to 180°.

On Bromo-nitrated Camphor.—P. Cazeneuve.—This compound crystallises from boiling alcohol at 83 per cent in magnificent prisms of an intense whiteness, insoluble in water, very soluble in ether, and melting at 103° to 104°. This compound is lævo-rotatory, like chloro-nitrated camphor α.

Combination of Gold Chlorides with Phosphorus Chlorides.—L. Lindet.—The author has obtained a compound of aurous chloride and phosphorus which crystallises in large oblique prisms, perfectly colourless. Its composition is Au_2ClPCl_3. It is soluble in phosphorus proto-chloride; neither fusible nor volatile, but becomes decomposed above 100°, liberating phosphorus monochloride, and leaving a complex residue not yet examined. The auric compound, $Au_2Cl_3PCl_5$, appears in the form of a light flocculent precipitate formed of fine microscopic needles of a citron yellow.

Reaction of Albumen and of a Synthetic Nitrogenous Colloid.—E. Grimaux.—A solution of an amido-benzoic colloid prepared by the author gives almost exactly the same reactions as a 1 per cent solution of albumen. The chief difference is that the amido-benzoic compound is precipitated by acetic acid, whilst that of albumen is not. The author remarks that the facts obtained demonstrate the error of physiologists who maintain that the substances of the greatest importance for life no longer present the character of chemical compounds. The author's researches on the contrary prove that the albumenoids owe their complex reactions to their character as colloidal bodies; they are chemical species or mixtures of species, which, when once removed from the living organism, obey physico-chemical laws.

Composition of the Saline Mineral Water of Salies-du-Salat.—P. Sabatier.—This water approaches in composition that of the Mediterranean, from which it is distinguished by a greater quantity of sulphates and a smaller proportion of bromides and iodides.

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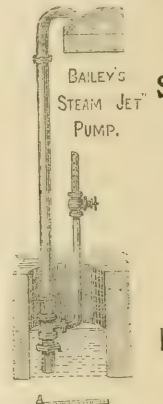

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THE CHEMICAL NEWS.

Vol. L. No. 1293.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By Prof. HENRY ENFIELD ROSCOE, PhD., LLD., F.R.S., F.C.S., President of the Section.

With the death of Berzelius in 1848 ended a well-marked epoch in the history of our science; with that of Dumas—and, alas! that of Wurtz—also—in 1884 closes a second. It may not perhaps be unprofitable on the present occasion to glance at some few points in the general progress which chemistry has made during this period, and thus to contrast the position of the science in the "sturm and drang" year of 1848, with that in the present, perhaps, quieter period.

The differences between what may properly be termed the Berzelian era and that with which the name of Dumas will for ever be associated show themselves in many ways, but in none more markedly than by the distinct views entertained as to the nature of a chemical compound.

According to the older notions, the properties of compounds are essentially governed by the qualitative nature of their constituent atoms, which were supposed to be so arranged as to form a binary system. Under the new ideas, on the other hand, it is mainly the number and arrangement of the atoms within the molecule which regulate the characteristics of the compound, which is to be looked on not as built up of two constituent groups of atoms, but as forming one group.

Amongst those who successfully worked to secure this important change of view on a fundamental question of chemical theory, the name of Dumas himself must first be mentioned, and, following upon him, the great chemical twin-brethren Laurent and Gerhardt, who, using both the arguments of test-tube and of pen in opposition to the prevailing views, gradually succeeded, though scarcely during the lifetime of the first, in convincing chemists that the condition of things could hardly be a healthy one when chemistry was truly defined "as the science of bodies which do not exist." For Berzelius, adhering to his preconceived notions, had been forced by the pressure of new discovery into the adoption of formulæ which gradually became more and more complicated, and led to more and more doubtful hypotheses, until his followers at last could barely succeed in building up the original radical from its numerous supposed component parts. Such a state of things naturally brought about its own cure, and the unitary formulæ of Gerhardt began to be generally adopted.

It was not, however, merely as an expression of the nature of the single chemical compound that this change was beneficial, but, more particularly, because it laid open the general analogies of similarly constituted compounds, and placed fact as the touchstone by which the constitution of these allied bodies should be ascertained. Indeed, Gerhardt, in 1852, gave evidence of the truth of this in his well-known theory of types, according to which, organic compounds of ascertained constitution can be arranged under the four types of hydrogen, hydrochloric acid, water, and ammonia, and of which it is, perhaps, not too much to say that it has, more than any other of its time, contributed to the clearer understanding of the relations existing amongst chemical compounds.

Another striking difference of view between the chemistry of the Berzelian era and that of what we sometimes term the modern epoch is illustrated by the so-called substitution theory. Dumas, to whom we owe this theory, showed that chlorine can take the place of hydrogen in many compounds, and that the resulting body possesses characters similar to the original. Berzelius opposed this view, insisting that the essential differences between these two elements rendered the idea of a substitution impossible, and notwithstanding the powerful advocacy of Liebig, and the discovery by Melsens of reverse substitutions (that is the re-formation of the original compound from its substitution-product), Berzelius remained to the end unconvinced, and that which was in reality a confirmation of his own theory of compound radicals, which, as Liebig says, "illumined many a dark chapter in organic chemistry," was looked upon him as an error of the deepest dye. This inability of many minds to see in the discoveries of others confirmation of their own views is not uncommon; thus Dalton, we may remember, could never bring himself to admit the truth of Gay-Lussac's laws of gaseous volume-combination, although, as Berzelius very truly says, if we write *atom* for *volume* and consider the substance in the solid state in place of the state of gas, the discovery of Gay-Lussac is seen to be one of the most powerful arguments in favour of Dalton's hypothesis.

But there is another change of view, dating from the commencement of the Dumas epoch, which has exerted an influence equal, if not superior, to those already named on the progress of our science. The relative weights of the ultimate particles, to use Dalton's own words, which up to this time had been generally adopted by chemists, were the equivalent weights of Dalton and Wollaston, representing, in the case of oxygen and hydrogen, the proportions in which these elements combine, viz., as 8 to 1. The great Swedish chemist at this time stood almost alone in supporting another hypothesis: for, founding his argument on the simple laws of volume-combination enunciated by Gay-Lussac, he asserted that the true atomic weights are to be represented by the relations existing between equal volumes of the two gases, viz., as 16 to 1. Still these views found no favour in the eyes of chemists until Gerhardt, in 1843, proposed to double the equivalent weights of oxygen, sulphur, and carbon, and then the opposition which this suggestion met with was most intense, Berzelius himself not even deigning to mention it in his annual account of the progress of the science, thus proving the truth of his own words: "That to hold an opinion habitually often leads to such an absolute conviction of its truth that its weak points are unregarded, and all proofs against it ignored." Nor were these views generally adopted by chemists until Cannizaro, in 1858, placed the whole subject on its present firm basis by clearly distinguishing between equivalent and molecular weights, showing how the atomic weights of the constituent elements are derived from the molecular weights of their volatile compounds based upon the law of Avogadro and Ampère, or where, as is the case with many metals, no compounds of known vapour-density exist, how the same result may be ascertained by the help of the specific heat of the element itself. Remarkable as it may appear, it is nevertheless true that it is in the country of their birth that Gerhardt's atomic weights and the consequent atomic nomenclature have met with most opposition, so much so that within a year or two of the present time there was not a single course of lectures delivered in Paris in which these were used.

The theory of organic radicals, developed by Liebig so long ago as 1834, received numerous experimental confirmations in succeeding years. Bunsen's classical research on cacodyl, proving the possibility of the existence of metallo-organic radicals capable of playing the part of a metal, and the isolation of the hydrocarbon ethyl by Frankland in 1849, laid what the supporters of the theory deemed the final stone in the structure.

The fusion of the radical and type theories, chiefly effected by the discovery in 1849 of the compound ammonias by Wurtz, brings us to the dawn of modern

chemistry. Henceforward organic compounds were seen to be capable of comparison with simple inorganic bodies, and hydrogen not only capable of replacement by chlorine, or by metal, but by an organic group or radical.

To this period my memory takes me back. Liebig and Giessen, Wöhler in Gottingen, Bunsen in Marburg, Dumas, Wurtz, and Laurent and Gerhardt in Paris, were the active spirits in continental chemistry. In our own country, Graham, whose memorable researches on the phosphates had enabled Liebig to found his theory of polybasic acids, was working and lecturing at University College, London; and Williamson, imbued with the new doctrines and views of the twin French chemists, had just been appointed to the chair of practical chemistry in the same college vacant by the death of poor Fownes. At the same time Hofmann, in whom Liebig found a spirit as enthusiastic in the cause of scientific progress as his own, bringing to England a good share of the Giessen fire, founded the most successful school of chemistry which this country has yet seen.

At the Edinburgh meeting of this Association in 1850, Williamson read a paper on "Results of a Research on Ætherification," which included not only a satisfactory solution of an interesting and hitherto unexplained problem, but was destined to exert a most important influence on the development of our theoretical views. For he proved, contrary to the then prevailing idea, that ether contains twice as much carbon as alcohol, and that it is not formed from the latter by a mere separation of the elements of water, but by an exchange of hydrogen for ethyl, and this fact being in accordance with Avogadro's law of molecular volumes, could only be represented by regarding the molecule of water as containing two atoms of hydrogen to one of oxygen, one of the former being replaced by one of ethyl to form alcohol, and the two of hydrogen by two of ethyl to form ether. Then Williamson introduced the type of water (subsequently adopted by Gerhardt) into organic chemistry, and extended our views of the analogies between alcohols and acids, by pointing out that these latter are also referable to the water-type, predicting that bodies bearing the same relations to the ordinary acids as the ethers do to the alcohols must exist, a prediction shortly afterwards (1852) verified by Gerhardt's discovery of the anhydrides. Other results followed in rapid succession, all tending to knit together the framework of modern theoretical chemistry. Of these the most important was the adoption of condensed types, of compounds constructed on the type of two and three molecules of water, with which the names of Williamson and Odling are connected, culminating in the researches of Brodie on the higher alcohols, of Berthelot on glycerin, and of Wurtz on the dibasic alcohols or glycols; whilst, in another direction, the researches of Hofmann on the compound amines and amides opened out an entirely new field, showing that either a part or the whole of the hydrogen in ammonia can be replaced by other elements or elementary groups without the type losing its characteristic properties.

Again, in 1852, we note the first germs of a theory which was destined to play an all-important part in the progress of the science, viz., the doctrine of valency or atomicity, and to Frankland it is that we owe this new departure. Singularly enough, whilst considering the symmetry of construction visible amongst the inorganic compounds of nitrogen, phosphorus, arsenic, and antimony, and whilst putting forward the fact that the combining power of the attracting element is always satisfied by the same number of atoms, he does not point out the characteristic tetrad nature of carbon; and it was not until 1858 that Couper initiated, and Kekulé, in the same year, thoroughly established the doctrine of the linking of the tetrad carbon atoms, a doctrine to which, more than to any other, is due the extraordinary progress which organic chemistry has made during the last twenty years, a progress so vast, that it is already found impossible for one individual, even though he devote his whole time and energies to the task, to master all the details, or make himself at home with the increasing mass of new facts which the busy workers in this field are daily bringing forth.

The subject of the valency of the elements is one which, since the year above referred to, has given chemists much food for discussion, as well as opportunity for experimental work. But whether we range ourselves with Kekulé, who supports the unalterable character of the valency of each element, or with Frankland, who insists on its variability, it is now clear to most chemists that the hard and fast lines upon which this theory was supposed to stand cannot be held to be secure. For if the progress of investigation has shown that it is impossible in many instances to affix one valency to an element which forms a large number of different compounds, it is also equally impossible to look on the opposite view as tending towards progress, inasmuch as to ascribe to an element as many valencies as it possesses compounds with some other element, is only expressing by circuitous methods what the old Daltonian law of combination in multiple proportions states in simple terms. Still we may note certain generally-accepted conclusions: in the first place that of the existence of non-saturated compounds both inorganic and organic, as carbon-monoxide on the one hand, and malic and citraconic acids on the other. Secondly, that the valency of an element is not only dependent upon the nature of the element with which it combines, but that this valency is a periodic function of the atomic weight of the other component. Thus the element of the chlorine group are always monads when combined with positive elements or radicals, but triad, pentad, and heptad with negative ones. Again, the elements of the sulphur group are dyads in the first case, but tetrad and hexad in the second. The periodicity of this property of the atoms, increasing and again diminishing, is clearly seen in such a series as—

$$AgCl_I,\ CdCl_2,\ InCl_3,\ SnCl_4,\ SbH_3,\ TeH_2,\ IH,$$

as well as in the series of oxides. The difficulties which beset this subject may be judged of by the mention of a case or two:—Is vanadium a tetrad because its highest chloride contains four atoms of chlorine? What are we to say is the valency of lead when one atom unites with four methyls to form a volatile product, and yet the vapour-density of the chloride shows that the molecule contains one of metal to two of chlorine? Or, how can our method be said to determine the valency of tungsten when the hexchloride decomposes in the state of vapour, and the penta-chloride is the highest volatile stable compound? How again are we to define the point at which a body is volatile without decomposition?—thus sulphur tetra-chloride, one of the most unstable of compounds, can be vapourised without decomposition at all temperatures below $-22°$, whilst water, one of the most stable of known compounds, is dissociated into its elements at the temperature of melting platinum.

But, however, many doubts may have been raised in special instances against a thorough application of the law of valency, it cannot be denied that the general relations of the elements which this question of valency has been the means of bringing to light are of the highest importance, and point to the existence of laws of nature of the widest significance; I allude to the periodic law of the elements first foreshadowed by Newlands, but fully developed by Mendeleeff and Lothar Meyer. Guided by the principle that the chemical properties of the elements are a periodic function of their atomic weights, or that matter becomes endowed with analogous properties when the atomic weight of an element is increased by the same or nearly the same number, we find ourselves for the first time in possession of a key which enables us to arrange the hitherto *disjectâ membra* of our chemical household in something like order, and thus gives us means of indicating the family resemblances by which these elements are characterised.

And here we may congratulate ourselves on the fact

that, by the recent experiments of Brauner, and of Nilson and Pettersen respectively, tellurium and beryllium, two of the hitherto outstanding members, have been induced to join the ranks, so that at the present time osmium is the only important defaulter amongst the sixty-four elements, and few persons will doubt that a little careful attention to this case will remove the stigma which yet attaches to its name. But this periodic law makes it possible for us to do more; for as the astronomer, by the perturbations of known planets, can predict the existence of hitherto unknown ones, so the chemist, though, of course, with much less satisfactory means, has been able to predict with precision the properties, physical and chemical, of certain missing links amongst the elements, such as ekaluminium and ekaboron, then unborn, but which shortly afterwards became well known to us in the flesh as gallium and scandium. We must, however, take care that success in a few cases does not blind us to the fact that the law of nature which expresses the relation between the properties of the elements and the value of the atomic weights is as yet unknown; that many of the groupings are not due to any well-ascertained analogy of properties of the elements, and that it is only because the values of their atomic weights exhibit certain regularities that such a grouping is rendered possible. So, to quote Lothar Meyer, we shall do well in this, as indeed in all similar cases in science, to remember the danger pointed out in Bacon's aphorism, that "The mind delights in springing up to the most general axioms, that it may find rest, but after a short stay here it disdains experience," and to bear in mind that it is only the lawful union of hypothesis with experiment which will prove a fruitful one in the establishment of a systematic inorganic chemistry which need not fear comparison with the order which reigns in the organic branch of our science. And here it is well to be reminded that complexity of constitution is not the sole prerogative of the carbon compounds, and that before this systematisation of inorganic chemistry can be effected we shall have to come to terms with many compounds concerning whose constitution we are at present wholly in ignorance. As instances of such I would refer to the finely crystalline phospho-molybdates, containing several hundred atoms in the molecule, lately prepared by Wolcott Gibbs.

Arising out of Kekulé's theory of the tetrad nature of the carbon atom, came the questions which have caused much debate among chemists: (1) Are the four combining units of the carbon atom of equal value or not? and (2) Is the assumption of a dyad carbon atom in the so-called non-saturated compounds justifiable or not? The answer to the first of these, a favourate view of Kolbe's, is given in the now well-ascertained laws of isomerism; and from the year 1862, when Schorlemmer proved the identity of the hydrides of the alcohol radicals with the so-called radicals themselves, this question may be said to be set at rest; for Lossen himself admits that the existence of his singular isomeric hydroxyl-amine derivatives can be explained otherwise than by the assumption of a difference between each of the combining units of nitrogen, and the differences supposed by Schreiner to hold good between the methyl-ethyl carbonic ethers have been shown to have no existence in fact. With respect to the second point the reply is no less definite, and is recorded in the fact, amongst others, that ethylene chlorhydrin yields on oxidation chloracetic acid, a reaction which cannot be explained on the hypothesis of the existence in ethylene of a dyad carbon atom.

Passing from this subject, we arrive, by a process of natural selection, at more complicated cases of chemical orientation—that is, given certain compounds which possess the same composition and molecular formulæ but varying properties, to find the difference in molecular structure by which such variation of properities is determined. Problems of this nature can now be satisfactorily solved, the number of possible isomers foretold, and this prediction confirmed by experiment. The general method adopted in such an experimental enquiry into the molecular arrangement or chemical constitution of a given compound is either to build up the structure from less complicated ones of known constitution, or to resolve it into such component parts. Thus, for example, if we wish to discriminate between several isomeric alcohols, distinguishing the ordinary or primary class from the secondary or tertiary class, the existence of which was predicted by Kolbe in 1862, and of which the first member was prepared by Friedel in 1864, we have to study their products of oxidation. If one yields an acid having the same number of carbon atoms as the alcohol, it belongs to the first class and possesses a definite molecular structure; if it splits up into two distinct carbon compounds, it is a secondary alcohol; and if three carbon compounds result from its oxidation, it must be classed in the third category, and to it belongs a definite molecular structure, different from that of the other two.

In a similar way orientation in the much more complicated aromatic hydro-carbons can be effected. This class of bodies forms the nucleus of an enormous number of carbon compounds which, both from a theoretical and a practical point of view, are of the highest interest. For these bodies exhibit characters and possess a constitution totally different from those of the so-called fatty substances, the carbon atoms being linked together more intimately than is the case in the latter-named group of bodies. Amongst them are found all the artificial colouring matters, and some of the most valuable pharmaceutical and therapeutical agents.

The discovery of the aniline colours by Perkin, their elaboration by Hofmann, the synthesis of alizarin by Graebe and Liebermann, being the first vegetable colouring matter which has been artificially obtained, the artificial production of indigo by Baeyer, and lastly the preparation by Fischer, of kairine, a febrifuge as potent as quinine, are some of the well-known recent triumphs of modern synthetical chemistry. And these triumphs, let us remember, have not been obtained by any such "random haphazarding" as yielded results in Priestley's time. In the virgin soil of a century ago, the ground only required to be scratched and the seed thrown in to yield a fruitful crop; now the surface soil has long been exhausted, and the successful cultivator can only obtain results by a deep and thorough preparation, and by a systematic and scientific treatment of his material.

In no department of our science has the progress made been more important than in that concerned with the accurate determination of the numerical, physical, and chemical constants upon the exactitude of which every quantitative chemical operation depends. For the foundation of an accurate knowledge of the first of these constants, viz., the atomic weights of the elements, science is indebted to the indefatigable labours of Berzelius. But "humanum est errare," and even Berzelius's accurate hand and delicate conscientiousness did not preserve him from mistakes, since corrected by other workers. In such determinations it is difficult, if not impossible, always to ascertain the limits of error attaching to the number. The errors may be due in the first place to manipulative faults, in the second to the inaccuracy of the methods, or lastly to mistaken views as to the composition of the material operation upon; and hence the uniformity of any series of similar determinations gives no guarantee of their truth, the only safe guide being the agreement of determinations made by altogether different methods. The work commenced by Berzelius has been worthily continued by many chemists. Stas and Marignac, bringing work of an almost astronomical accuracy into our science, have ascertained the atomic weights of silver and iodine to within one hundred-thousandth of their value, whilst the numbers for chlorine, bromine, potassium, sodium, nitrogen, sulphur, and oxygen may now be considered correct to within a unit in the fourth figure. Few of the elements, however, boast numbers approaching this degree of accuracy, and many may even still be erroneous, from half to a whole unit of hydrogen. And (as Lothar Meyer says)

until the greater number of the atomic weights are determined to within one or two tenths of the unit, we cannot expect to be able to ascertain the laws which certainly govern these numbers, or to recognise the relations which undoubtly exist between them and the general chemical and physical properties of the elements. Amongst the most interesting recent additions to our knowledge made in this department we may note the classical experiments, in 1880, of J. W. Mallet on aluminium, and in the same year of J. P. Cooke on antimony, and those, in the present year, of Thorpe on titanium.

Since the date of Berzelius's death to the present day no discovery in our science has been so far-reaching, or led to such unforeseen and remarkable conclusions, as the foundation of Spectrum Analysis by Bunsen and Kirchhoff in 1860.

Independently altogether of the knowledge which has been gained concerning the distribution of the elementary bodies in terrestrial matter, and of the discovery of half-a-dozen new elements by its means, and putting aside for a moment the revelation of a chemistry not bounded by this world, but limitless as the heavens, we find that over and above all these results spectrum analysis offers the means, not otherwise open to us, of obtaining knowledge concerning the atomic and molecular condition of matter.

Let me recall some of the more remarkable conclusions to which the researches of Lockyer, Schuster, Liveing and Dewar, Wüllner, and others in this direction have led. In the first place it is well to bear in mind that a difference of a very marked kind, first distinctly pointed out by Alex. Mitscherlich, is to be observed between the spectrum of an element and that of its compounds, the latter only being seen in cases in which the compound is not dissociated at temperatures necessary to give rise to a glowing gas. Secondly, that these compound spectra—as, for instance, those of the halogen compounds of the alkaline-earth metals—exhibit a certain family likeness, and show signs of systematic variation in the position of the lines, corresponding to changes in the molecular weight of the vibrating system. Still this important subject of the relation of the spectra of different elements is far from being placed on a satisfactory basis, and in spite of the researches of Lecoq de Boisbaudran, Ditte, Troost and Hautefeuille, Ciamician, and others, it cannot be said that as yet definite proof has been given in support of the theory that a causal connection is to be found between the emission spectra of the several elements belonging to allied groups and their atomic weights or other chemical or physical properties. In certain of the single elements, however, the connection between the spectra and the molecular constitution can be traced. In the case of sulphur, for example, three distinct spectra are known. The first of these, a continuous one, is exhibited at temperatures below 500°, when, as we know from Dumas's experiments, the density of the vapour is three times the normal, showing that at this temperature the molecule consists of six atoms, The second spectrum is seen when the temperature is raised to above 1000°, when, as Deville and Troost have shown, the vapour reaches its normal density, and the molecule of sulphur, as with most other gases, contains two atoms, and this is a band spectrum, or one characterised by channelled spaces. Together with this band spectrum, and especially round the negative pole, a spectrum of bright lines is observed. This latter is doubtless due to the vibrations of the single atoms of the dissociated molecule, the existence of traces of a band spectrum demonstrating the fact that in some parts of the discharge the tension of dissociation is insufficient to prevent the reunion of the atoms to form the molecule.

To this instance of the light thrown on molecular relations by changes in the spectra, others may be added. Thus the low-temperature spectrum of channelled spaces, mapped by Schuster and myself, in the case of potassium, corresponds to the molecule of two atoms and to the vapour-density of seventy-nine, as observed by Dewar and Dittmar. Again, both oxygen and nitrogen exhibit two, if not three, distinct spectra; of these the line spectrum seen at the highest temperatures corresponds to the atom; the band spectrum seen at intermediate temperatures represents the molecule of two atoms; whilst that observed at a still lower point would, as in the case of sulphur, indicate the existence of a more complicated molecule, known to us in one instance as ozone.

That this explanation of the cause of these different spectra of an element is the true one, can be verified in a remarkable way. Contrary to the general rule amongst those elements which can readily be volatilised, and with which, therefore, low-temperature spectra can be studied, mercury exhibits but one spectrum, and that one of bright lines, or, according to the preceding theory, a spectrum of atoms. So that, judging from spectroscopic evidence, we infer that the atoms of mercury do not unite to form a molecule, and we should predict that the vapour-density of mercury is only half its atomic weight. Such we know, from chemical evidence, is really the case, the molecule of mercury being identical in weight with its atom.

The cases of cadmium and iodine require further elucidation. The molecule of gaseous cadmium, like that of mercury, consists of one atom; probably, therefore, the cadmium spectrum is also distinguished by one set of lines. Again, the molecule of iodine at 1200° separates, as we know from Victor Meyer's researches, into single atoms. Here spectrum analysis may come again to our aid; but, as Schuster remarks, in his report on the spectra of the non-metallic elements, a more extensive series of experiments than those already made by Ciamician is required before any definite opinion as to the connection of the different iodine spectra with the molecular condition of the gas can be expressed.

It is not to be wondered at that these relations are only exhibited in the case of a few elements. For most of the metals the vapour-density remains, and probably will remain, an unknown quantity, and therefore the connection between any observed changes in the spectra and the molecular weights must also remain unknown. The remarkable changes which the emission spectrum of a single element—iron, for instance—exhibits have been the subject of much discussion, experimental and otherwise. Of these, the phenomenon of long and short lines is one of the most striking, and the explanation that the long lines are those of low temperature appears to meet the facts satisfactorily, although the effect of dilution—that is, a reduction of the quantity of material undergoing volatilisation—is, remarkably enough, the same as that of diminution of temperature. Thus it is possible, by the examination of a spectrum by Lockyer's method, to predict the changes which it will undergo, either on alteration of temperature or by an increase or decrease of quantity. There appears to be no theoretical difficulty in assuming that the relative intensity of the lines may vary when the temperature is altered, and the molecular theory of gases furnishes us with a plausible explanation of the corresponding change when the relative quantities of the luminous elements in a mixture are altered. Lockyer has proposed a different explanation of the facts. According to him every change of relative intensity means a corresponding change of molecular complexity, and the lines which we see strong near the poles would bear the same relation to those which are visible throughout the field as a line spectrum bears to a band spectrum; but then almost every line must be due to a different molecular grouping, a conclusion which is scarcely capable of being upheld without very cogent proof.

The examination of the absorption spectra of salts, saline and organic liquids, first by Gladstone, and afterwards by Bunsen and by Russell, as well as by Hartley for the ultra-violet, and by Abney and Festing for the infra-red region, have led to interesting results in relation to molecular chemistry. Thus Hartley finds that in some of the more complicated aromatic compounds, definite absorption bands in the more refrangible region are only

produced by substances in which three pairs of carbon atoms are doubly linked, as in the benzene ring, and thus the means of ascertaining this double linkage is given. The most remarkable results obtained by Abney and Festing show that the radical of an organic body is always represented by certain well-marked absorption bands, differing, however, in position, according as it is linked with hydrogen, a halogen, or with carbon, oxygen, or nitrogen. Indeed these experimenters go so far as to say that it is highly probable that by this delicate mode of analysis the hypothetical position of any hydrogen which is replaced may be identified, thus pointing out a method of physical orientation of which, if confirmed by other observers, chemists will not be slow to avail themselves. This result, it is interesting to learn, has been rendered more than probable by the recent important researches of Perkin on the connection between the constitution and the optical properties of chemical compound.

One of the noteworthy features of chemical progress is the interest taken by physicists in fundamental questions of our science. We all remember, in the first place, Sir William Thomson's interesting speculations, founded upon physical phenomena, respecting the probable size of the atom, viz., "that if a drop of water were magnified to the size of the earth, the constituent atoms would be larger than small shot, but smaller than cricket balls." Again, Helmholtz in the Faraday lecture, delivered in 1881, discusses the relation of electricity and chemical energy, and points out that Faraday's law of electrolysis, and the modern theory of valency, are both expressions of the fact that when the same quantity of electricity passes through an electrolyte it always either sets free, or transfers to other combinations, the same number of units of affinity at both electrodes. Helmholtz further argues that if we accept the Daltonian atomic hypothesis we cannot avoid the conclusion that electricity, both positive and negative, is divided into elementary portions which behave like atoms of electricity. He also shows that these charges of atomic electricity are enormously large as compared, for example, with the attraction of gravitation between the same atoms; in the case of oxygen and hydrogen, 71,000 billion times larger.

A further subject of interest to chemists is the theory of the vortex-ring constitution of matter thrown out by Sir William Thomson, and lately worked out from a chemical point of view by J. J. Thomson, of Cambridge. He finds that if one such ring be supposed to constitute the most simple form of matter, say the monad hydrogen atom, then two such rings must, on coming into contact with nearly the same velocity, remain enchained together, constituting what we know as the molecule of free hydrogen. So, in like manner, systems containing two, three, and four such rings constitute the dyad, triad, and tetrad atoms. How far this mathematical expression of chemical theory may prove consistent with fact remains to be seen.

Another branch of our science which has recently attracted much experimental attention is that of thermochemistry, a subject upon which in the future the foundation of dynamical chemistry must rest, and one which already proclaims the truth of the great principle of the conservation of energy in all cases of chemical as well as of physical change. But here, although the materials hitherto collected are of very considerable amount and value, the time has not yet arrived for expressing these results in general terms, and we must therefore be content to note progress in special lines and wait for the expansion into wider areas. Reference may, however, be properly made to one interesting observation of general significance. It is well known that, while in most instances the act of combination is accompanied by evolution of heat,—that is, whilst the potential energy of most combining bodies is greater than that of most compounds,—cases occur in which the reverse of this is true, and heat is absorbed in combination. In such cases the compound readily undergoes decomposition, frequently suddenly and with explosion. Acetylene and cyanogen seem to be exceptions to this rule, inasmuch as, whilst their component elements require to have energy added to them in order to enable them to combine, the compounds appear to be very stable bodies. Berthelot has explained this enigma by showing that, just as we may ignite a mass of dynamite without danger, whilst explosion takes place if we agitate the molecules by a detonator, so acetylene and cyanogen burn, as we know, quietly when ignited, but when their molecules are shaken by the detonation of even a minute quantity of fulminate the constituents fly apart with explosive violence, carbon and hydrogen, or carbon and nitrogen being set free, and the quantity of heat absorbed in the act of combination being suddenly liberated.

In conclusion, whilst far from proposing even to mention all the important steps which our science has advanced since the year 1848, I cannot refrain from referring to two more. In the first place, to that discovery, more than foreshadowed by Faraday, of the liquefaction of the so-called permanent gases by Pictet and Cailletet; and secondly, to that of the laws of dissociation as investigated by Deville. The former, including Andrews's discovery of the critical point, indicates a connection, long unseen, between the liquid and the gaseous states of matter; the latter has opened out entirely fresh fields for research, and has given us new views concerning the stability of chemical compounds of great importance and interest.

Turning for a moment to another topic, we feel that, although Science knows no nationalities, it is impossible for those who, like ourselves, exhibit strong national traits to avoid asking whether we Anglo-Saxons hold our own, as compared with other nations, in the part we have played and are playing in the development of our science. With regard to the past, the names of Boyle, Cavendish, Priestley, Dalton, Black, Davy, are sufficient guarantees that the English have, to say the least, occupied a position second to none in the early annals of chemistry. How has it been in the era which I have attempted to describe? What is the present position of English chemistry, and what its look-out for the future? In endeavouring to make this estimate I would take the widest ground, including not only the efforts made to extend the boundaries of our science by new discovery, both in the theoretical and applied branches, but also those which have the no less important aims of spreading the knowledge of the subject amongst the people, and of establishing industries dependent on chemical principles by which the human race is benefitted. Taking this wide view I think we may, without hesitation, affirm that the progress which chemistry has made through the energies of the Anglo-Saxon race is not less than that made by any other nation.

In so far as pure science is concerned I have already given evidence of the not inconsiderable part which English chemists have played in the progress since 1848. We must, however, acknowledge that the number of original chemical papers now published in our language is much smaller than that appearing in the German tongue, and that the activity and devotion displayed in this direction by the heads of German laboratories may well be laid to heart by some of us in England; yet, on the other hand, it must be remembered that the circumstances of different countries are so different that it is by no means clear that we should follow the same lines. Indeed our national characteristics forbid us to do so, and it may be that the bent of the Germanic lies in the assiduous collection of facts, whilst their subsequent elaboration and connection is the natural work of our own race.

As regards the publication of so-called original work by students, and speaking now only for myself as the director of an English chemical laboratery, I feel I am doing the best for the young men who, wishing to become either

scientific or industrial chemists, are placed under my charge, in giving them as sound and extensive a foundation in the theory and practice of chemical science as their time and abilities will allow, rather than forcing them prematurely into the preparation of a new series of homologous compounds, or the investigation of some special reaction, or of some possible new colouring-matter, though such work might doubtless lead to publication. My aim has been to prepare a young man, by a careful and fairly complete general training, to fill with intelligence and success a post either as teacher or industrial chemist, rather than to turn out mere specialists, who, placed under other conditions than those to which they have been accustomed, are unable to get out of the narrow groove in which they have been trained. And this seems a reasonable course, for whilst the market for the pure specialist—as the colour chemist, for example—may easily be overstocked, the man of all-round intelligence will always find opportunity for the exercise of his powers. Far, however, from underrating the educational advantages of working at original subjects, I consider this sort of training to be of the highest and best kind, but only useful when founded upon a sound and general basis.

The difficulty which the English teacher of chemistry—and in this I may include Canada and the United States—has to contend against is, that whilst in Germany the value of this high and thorough training is generally admitted, in England a belief in its efficacy is as yet not generally entertained. "The Englishman," to quote from the recent Report of the Royal Commission on Technical Instruction, "is accustomed to seek for an immediate return, and has yet to learn that an extended and systematic education, up to and including the methods of original research, is now a necessary preliminary to the fullest development of industry; and it is to the gradual but sure growth of public opinion in this direction that we must look for the means of securing to this country in the future, as in the past, the highest position as an industrial nation."

If, in the second place, we consider the influence which Englishmen have exerted on the teaching of our science, we shall feel reason for satisfaction; many of our textbooks are translated into every European language and largely used abroad—often to the exclusion of those written by continental chemists.

Again, Science teaching, both practical and theoretical, in our elementary and many secondary schools, is certainly not inferior to that in schools of similar grade abroad, and the interest in and desire for scientific training is rapidly spreading throughout our working population, and is even now as great as, if not greater than, abroad. The universities and higher colleges are also moving to take their share of the work which has hitherto been far less completely done in our country than on the continent of Europe, especially in Germany, where the healthful spirit of competition, fostered by the numerous State-supported institutions, is much more common than with us, and, being of equal value in educational as in professional or commercial matters, has had its due effect.

Turning lastly to the practical applications of our science, in what department does England not excel? and in which has she not made the most important new departures? Even in colour chemistry, concerning which we have heard, with truth, much of German supremacy, we must remember that the industry is originally an English one, as the names of Perkin and of Maule, Simpson and Nicholson testify; and if we have hitherto been beaten hollow in the development of this branch, signs are not wanting that this may not always be the case. But take any other branch of applied chemistry,—the alkali trade, for instance,—what names but English, with the two great exceptions of Leblanc and Solvay, do we find in connection with real discoveries? In the application of chemistry to metallurgical processes, too, the names of Darby, Cort, Neilson, and Bell in iron; of Bessemer, Thomas, Gilchrist, and Snelus in steel; of Elkington and Matthey in the noble metals, show that in these branches the discoveries which have revolutionised processes have been made by Englishmen; whilst Young, the father of paraffin, Spence the alum maker, and Abel of gun-cotton fame are some amongst many of our countrymen whose names may be honourably mentioned as having founded new chemical industries.

Hence, whilst there is much to stimulate us to action in the energy and zeal shown by our continental brethren in the pursuit both of pure and applied chemistry, there is nothing to lead us to think that the chemistry of the English-speaking nations in the next fifty years will be less worthy than that of the past half-century of standing side by side with that of her friendly rivals elsewhere.

ESTIMATION OF MANGANESE IN CAST-IRON AND SPIEGELEISEN.

By CHARLES L. BLOXAM.

THE estimation of small quantities of manganese in presence of much iron by converting the latter into ferric acetate, and boiling the largely diluted solution to precipitate the iron as basic ferric acetate, is troublesome on account of the large volume of liquid to be boiled and filtered; an operation which must be repeated, for unless the basic ferric acetate be re-dissolved and re-precipitated, the whole of the manganese is not obtained. Moreover, an unpractised operator frequently fails to effect complete precipitation of the iron, or obtains the precipitate in such a condition that filtration is very difficult.

A more convenient process, which I have not found described elsewhere, consists in precipitating the iron as ferric phosphate in presence of acetic acid, which retains the manganese dissolved. The metal is dissolved in HCl in a small beaker, the solution evaporated to dryness in the beaker, the residue dissolved in water with a little HCl, filtered from graphite and silica, the filtrate peroxidised by adding a few crystals of $KClO_3$ and heating, diluted with a convenient quantity of water, NH_3 added till the first-formed precipitate dissolves reluctantly on stirring, NH_3 mixed with excess of acetic acid (added in sufficient quantity to convert all the iron into acetate) and an excess of sodium phosphate. The cream-coloured precipitate of ferric phosphate is filtered off, the precipitate re-dissolved (without washing) in HCl, the solution again nearly neutralised with NH_3 and precipitated with the mixture of NH_3 with excess of acetic acid. The two filtrates are mixed, an excess of NH_3 added and boiled, when the manganese is precipitated as the crystalline, very insoluble ammonio-phosphate, which is filtered off and washed. As soon as the washings leave no residue on evaporation, the wet filter, with the precipitate, is placed in a platinum crucible, which is then covered and quickly heated to redness by a Bunsen burner. After ignition, the precipitate is $Mn_2P_2O_7$. (The precipitation of manganese as ammonio-phosphate was recommended by Dr. Wolcott Gibbs; see CHEMICAL NEWS, vol. xvii., p. 195.)

It is well, if possible, to keep the ammoniacal solution near its boiling-point for an hour, and to set it aside for the night, though the greater part of the manganese is precipitated at once on ebullition. The ignited precipitate should be re-dissolved in HCl and the solution mixed with ammonium acetate, to detect any ferric phosphate, which, if worth notice, may be ignited, weighed, and deducted.

For the determination of manganese in a sample of spiegeleisen, 10 grains were taken. This required about 100 grains of crystallised sodium phosphate. Three determinations gave,—for the percentage of Mn, 10·1, 10·05, and 9·98.*

Precipitation of the iron as basic acetate, and of the manganese as dioxide by bromine, gave 10·47 per cent;

* The ferric phosphate was found to be free from manganese.

the precipitate containing, in addition to the manganese, the small quantities of copper, &c., which bromine always precipitates from the slightly ammoniacal solution.

To estimate the manganese in a sample of grey cast-iron 50 grains were employed; the iron being precipitated by about 300 grains of crystallised sodium phosphate in a solution diluted to about ten ounces. Two determinations gave for the percentage of Mn 0·92 and 0·87, whilst the basic acetate and bromine process gave, in two cases, 0·87 and 0·83.

Doubtless a closer agreement in the results would be arrived at by constant practice in the process.

King's College, London,
August 20, 1884.

ON THE

ELECTRO-DEPOSITION OF CARBON, &c.*

By G. GORE, LL.D., F.R.S.

THE following experiments were made as attempts to electro-deposit carbon, boron, and silicon: –

1. A fused mixture of 200 grains of pure sodic hydrate, 170 grains of pure precipitated silica, and 610 grains of the mixed anhydrous carbonates of potassium and sodium, was electrolysed by means of a current from ten Smee's elements, with a sheet platinum anode, and a thick platinum wire cathode. The conduction was free, and much oxygen, which re-lighted a red-hot splint, was liberated at the anode. Dark streams flowed from the cathode; sodium was also set free, and if the cathode was only slightly immersed, bubbles of sodium vapour were emitted and took fire at the surface of the liquid. After one hour's action the platinum anode had lost 0·37 grain in weight. The cathode had a feebly adherent rough deposit of a dull jet-black colour upon it. This deposit was subsequently washed and dried; a portion of it burned with a glow when heated to redness on platinum, and left a minute residue of grey platinum: it also deflagrated with fused nitre below a red heat, and vividly by heating with potassic chlorate. It did not dissolve nor evolve any gas in a mixture of strong nitric acid and pure concentrated hydrofluoric acid. It was, therefore, not silicon but carbon containing a minute quantity of platinum.

As carbon was not readily deposited from the fused carbonates of potassium and sodium (see Expt. 4), whilst silicon was deposited from the fused silico-fluoride of potassium (see Expt. 3); and as an excess of silicon fused with potassic carbonate sets free carbon, but silicon with an excess of the carbonate liberates carbonic oxide, the carbon liberated in the present experiment may have been a secondary result, and an effect of previously deposited silicon reacting upon the fused mixture. It was with an expectation of this effect that I employed silica in the mixture.

2. I also electrolysed in a platinum cup a fused mixture of 475·2 grains of 97·1 per cent sodic carbonate,† and 217·4 grains of boro-fluoride of sodium, by means of the same current; a sheet platinum anode and thick platinum wire cathode. Conduction was free. Gas arose from the anode. A small amount of black deposit formed on the wire. After having been well washed, the deposit was dried, put on a platinum dish, and heated to redness; it burned with sudden incandescence until nearly the whole was consumed; it was therefore nearly wholly carbon.

3. I electrolysed in a platinum cup a fused mixture of 300 grains of 97·1 per cent pure potassic carbonate and 442 grains of silico-fluoride of potassium, by a current from ten Smee's cells, a sheet platinum anode, and a platinum wire cathode. Gas arose from the anode, and at first only gas arose from the cathode also. After that streams of black matter poured down from the cathode, and the latter acquired a blackish film, but subsequently became alloyed, and fused on its surface. The deposit was therefore partly or wholly silicon.

4. A mixture of 10 parts of pure anhydrous sodic carbonate and 13 parts of pure anhydrous potassic carbonate was fused in a platinum cup, and electrolysed by a current from eight Smee's cells and platinum electrodes at a red-heat. Very free conduction occurred. Gas was copiously evolved from the anode; an abundant liberation of sodium occurred at the cathode. No gas arose at the cathode, but dark streams issued from it beneath the surface of the liquid. The anode became brown, but had lost only 0·9 grain during an hour-and-a-half's action. The cathode did not alloy with the sodium but became brown, and was corroded at the surface of the liquid. A thin cathode of pure gold soon alloyed with the sodium, and melted at its extremity, although the temperature was below that of melting silver (probably in consequence of alloying with sodium); a thick one also gave off sodium vapour, alloyed and fused. A thick cathode of pure silver gave off sodium freely, but was soon cut in two at the surface of the liquid; its end became arborescent as if it had absorbed vapour of sodium, and expelled it again as does oxygen. No free carbon appeared.

5. I also electrolysed a mixture of 274 grains of pure sodic carbonate, 375 grains of pure potassic carbonate, both anhydrous, and 206 grains of crystallised boracic acid, in a similar manner at a red-heat. There was free conduction, much gas from the anode, and an instant jet-black deposit formed upon the cathode, and could be burned off by a red heat. Metallic sodium was set free at the cathode, especially during deep immersion. The anode was soon much corroded, and acquired a very smooth surfabe, and platinum was deposited upon the cathode. No free carbon was ultimately found.

6. Potassic cyanide, fused in a porcelain crucible, was electrolysed by means of a current from twenty-five Smee's cells, with a coke anode and an iron cathode. Free action occurred; much gas was evolved from the carbon, and some from the iron. A blackish deposit formed upon the iron and sank to the bottom. A platinum cathode dissolved quickly.

7. Melted potassic cyanide in a porcelain capsule was electrolysed by means of a gas carbon anode, a thin platinum wire cathode, and a current from two cells of zinc and platinum in dilute sulphuric acid. No deposit occurred on the cathode in a quarter of an hour.

8. I electrolysed distilled water by means of a current from thirty Smee's cells and a gas carbon anode of fine quality, and a platinum wire cathode, the two electrodes being very close together. Very faint conduction occurred. The water became brownish in one hour; the carbon of the anode produced this effect. The anode was slightly disintegrated on the side towards the cathode. No deposit of carbon occurred.

9. By means of a current from the same battery, and a plumbago anode, I electrolysed a solution of potassic hydrate (with and without addition of oxalic acid). Free action occurred, and plenty of gas came from both electrodes. Saturated solutions of oxalic acid in hydrochloric acid and in nitric acid were also electrolysed by means of platinum electrodes. No carbon was deposited in either case.

10. I electrolysed a solution of pure formiate of sodium and the strongest formic acid, by means of a current from four Smee's cells and electrodes of platinum. A black film deposit formed upon the cathode; it was not platinum nor carbon, but apparently oxide of iron.

11. Some oxalic acid was melted in its water of crystallisation, and the liquid electrolysed by the current from two small Smee's cells with platinum electrodes. Conduction was very feeble. Gas was evolved, but no solid deposit occurred.

12. I passed an electric current during one week from four Smee's cells, by means of platinum wires, through

* Read before the Birmingham Philosophical Society, June, 1884.
† The impurity consisted wholly of water.

pure, very dilute sulphuric acid in a large V glass tube, one leg of which was kept full of a mixture of carbonic oxide and carbonic anhydride gases. The anode acquired a thin reddish coating, which dissolved soon after the current was stopped. No carbon was deposited.

13. A cold saturated solution of pyrogallic acid in water was electrolysed by means of a current from twenty-five Smee's cells, a large platinum anode, and a platinum wire cathode. Gas came rather freely from the wire, but none from the anode, and the liquid became quite brown by oxidation. No carbon was deposited.

14. Strong hydrochloric acid containing a large gas carbon anode, and a very small platinum wire cathode, was electrolysed by means of a current from thirty strong Smee's cells. Free action took place. Much gas came from both electrodes; apparently chlorine from the anode and hydrogen from the cathode. The cathode soon became black, but not when it was deeply immersed.

15. A carbon anode in pure nitric acid was rapidly disintegrated by a current from two Smee's cells. The conduction was free. A gas carbon anode was also much disintegrated in a solution of potassic chromate by a current from thirty Smee's cells. Gas came from both electrodes.

16. Hydrocyanic acid gas liquefied by cold, and containing a little water, was saturated with carbonic oxide gas, and a current from three to twelve cells of a Smee's battery passed through the liquid by means of two fine platinum wires. Gas was evolved from the cathode only. After three hours action no carbon was deposited.

17. Fuming Nordhausen sulphuric acid, also a syrupy solution of phosphoric acid, were saturated with dry carbonic anhydride, and then electrolysed by means of platinum wire electrodes, and currents from 112 Smee's cells in single series. Carbon was not deposited.

18. A saturated solution of oxalic acid in water was electrolysed by means of a current from ten Smee's cells, a charcoal anode, and platinum wire cathode, in a hermetically closed glass tube. Gas was evolved, and the cathode became black. As the pressure increased the conduction diminished, and at a pressure of about 50 or 60 atmospheres the tube burst. By the electrolysis of a saturated solution of oxalic acid in alcohol, with electrodes of platinum wire, a thin black deposit was formed upon the cathode.

19. The degrees of electric conduction resistance of distilled water, and water saturated with carbonic anhydride at 60° F., were examined. No conspicuous difference was perceived.

20. A current of coal-gas was passed during fourteen days through a glass vessel over dilute sulphuric acid, the acid liquid being constantly electrolysed by means of four Smee's cells and platinum wire electrodes. A little gas was evolved from the wires all the time, but no signs of deposited carbon appeared.

21. The electric current from a battery of three cells, composed of magnesium and palladium wires in water, conducted into water above a layer of CCl_4 by a purified gas carbon anode, and palladium wire cathode, did not set free carbon.

22. The dry brown salt produced by exposing thin sheets of potassium to the vapour of carbonic bisulphide was dissolved in ether, and the solution electrolysed by a current from twenty-five Smee's cells, and platinum wire electrodes. Much gas was evolved from the cathode, but no carbon set free.

Several of these experiments prove that carbon, boron, and silicon may be separated from their melted compounds by means of electrolysis; but although carbon was slowly deposited in several cases, in no instance was it obtained from an aqueous solution or in a crystalline state.

Action of Nascent Hydrogen upon Acetamide.—J. Ch. Essner.—The results obtained are alcohol, aldehyd, and an oily product which is decomposed on distillation. The evolution of ammonia is very distinct.—*Bull. Soc. Chim.*

QUANTITATIVE DETERMINATION OF VERY SMALL QUANTITIES OF SILVER.

By CARL FRIEDRICH FÖHR.

PROPORTIONS of silver which only form fractions of a thousandth per cent can be determined in the dry way. Besides the ordinary methods, which, when the proportion of silver is small, require much material and time, there is another dry process, the blowpipe test, which leads rapidly and accurately to the object required, but demands great skill and experience. The author makes use of a combination of the two methods for the determination of minimum quantities of silver, which gives very good results without requiring more time than an ordinary assay. The resulting bead of silver is measured on a blowpipe gauge.

Before describing the precautions and minutiæ of this combination process it may be well to give a short account of the process of measurement employed in the present method as well as in the blowpipe assay.

As in the quantitative blowpipe assay for silver only 0·1 grm. = 1 blowpipe centimetre, is weighed out, the reguli, if the ore is poor, are too small to be weighed. Harkort first came upon the notion of measuring these globules and then calculating the percentage, since the weights of spheres of a metal are as the cubes of their diameter. To ascertain the latter, Harkort, and after him Plattner, made use of a narrow plate of ivory, upon which are drawn two converging lines with a maximum distance of 1 milimetre. These lines were about 15·5 centimetres in length to their point of intersection, and were divided by cross lines into 50 equal parts. In order to determine the values of this scale Harkort proceeded empirically, since the reguli are not mathematical spheres. He determined the proportion of silver in an ore accurately, by a series of assays in the muffle, selected then the most faultless bead of silver and moved it along between the converging lines of his scale till it touched them on both sides. At this point the proportion was noted in percentages calculated in blowpipe proof centners.

The other values were ascertained by calculation. If the necessary precautions are observed in reading off there are obtained with the scale good results, which agree perfectly with those obtained by cupellation. It is possible with the aid of a lens in measuring to determine with ease a proportion of 0·005 per cent of silver.

Sometimes, however, in the examination of poor burnt pyrites, &c., a much higher degree of accuracy is required. This can, however, be readily obtained by a combination of both methods. The bead obtained in the muffle from, *e.g.*, 10 grms. of raw material is measured on the blowpipe scale, and the percentage is calculated according to the quantity taken. But since, as already mentioned, with the aid of the lens a bead may be measured which in the blowpipe assay (0·1 grm. taken) represents a percentage of 0·005 silver, it follows that by the combination method a percentage of $\frac{0{\cdot}005}{100} = 0{\cdot}00005$ (10 grms. being taken) can be quite as readily determined.

Indeed, accuracy can be carried as far as is desirable. If we, for instance, combine the crucible assay with the blowpipe measurement we may determine a percentage of $\frac{0{\cdot}005}{1000} = 0{\cdot}000005$, if 100 grms. have been taken.

Besides, the combination method is much more accurate than the blowpipe assay, since an error committed during measuring is divided by 100 if we take 10 grms., and by 1000 if we take 100 grms.

As a degree of accuracy of 1-100000 per cent is sufficient even for the most delicate purposes, for instance, in petrographic researches in the origin of metallic veins, this silver-assay may be easily executed with the aid of a small muffle furnace, such as is generally to be found in laboratories for determining ashes, opening up ores, &c.

In order to determine proportions of silver of 0·0002 to

0·0007 per cent, the author proceeds as follows:—Into a small crucible of fire-clay are put about 20 grms. of a mixture of equal parts flour and potash. Upon this is placed the substance in question, carefully weighed (10 grms.). The whole is thoroughly mixed and covered with about 30 grms. of proof-lead, free from silver. The whole charge is then covered with sodium chloride and the crucible is placed in the muffle, which has been raised to a cherry-red heat, and left there for about three hours at a bright red heat until all the mass has been thoroughly liquefied.

Generally only two crucibles are used, assay and check-assay, placed in the muffle, and only if the silver is below 0·0002 per cent are four crucibles used, each with 10 grms. of the substance, the reguli being scorified together.

The lead reguli are generally too large to be at once driven off; they are generally scorified once and then transferred to the cupels.

In order to obtain a round, even bead, the operation is interrupted when the regulus is about of the size of a poppy seed, and completed in a second cupel. As soon as the cupel begins to fume it is drawn a little forward, and the aperture of the muffle is opened to prevent the bead from spitting by cooling slowly. Even the smallest beads spit if cooled too quickly.

The second driving may be advantageously effected before the blowpipe, as losses of silver are thus more readily avoided.

The bead of silver should be perfectly bright and white; it is carefully, and without great pressure, removed from the cupel by means of a forceps and a pointed knife, and cleansed by rubbing between blotting-paper.

Whilst measuring, the eye, in order to avoid parallax, is kept as nearly as possible vertically above the bead, the latter lying on the same surface as it did in the cupel. The measurement is repeated at least three times, with intervals, turning the bead in the same plane. The arithmetical mean divided by 100, if 10 grms. have been taken, is the proportion of silver.

Of course it is necessary before all things to ascertain whether the proof-bead used is absolutely free from silver. From 10 to 20 grms. are therefore examined according to the method above mentioned. Any silver found must then be deducted in subsequent operations.

Whether the combination method is applicable with the same accuracy to the determination of gold must be decided experimentally.

The method is especially suitable for very poor silicates and requires only from four-and-a-half to five hours for completion.—*Zeitschrift fur Analyt. Chemie.*

NOTICES OF BOOKS.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. lxxxix., January to June, 1884. London: Simpkin, Marshall, and Co.

THIS volume contains much matter which will be found interesting to many educated men outside the medical profession. We may especially notice an article on malarial poisoning, by Dr. W. Johnstone Fyffe, Deputy Surgeon-General. The author gives the sad history of the Walcheren Expedition, and the almost equally lamentable story of the British army under Lord Raglan whilst encamped for four months in Bulgaria. He gives the following facts as proofs of the existence of a malarial poison germ:—These fevers have a period of incubation, followed by "fever-storm"; they have special organic lesions; the destructive effects of the poison upon the blood are demonstrable by actual observation; the evidence of the communicability of the poison through potable water is very strong; and the influence of antidotes, such as quinine, arsenic, eucalyptus, &c., in counteracting the effects of the poison is clearly manifest. The author glances at the success of the Trappist monks in the sanitation of some of the most unhealthy districts in Italy, and reminds us that in England malarial fever was once a veritable plague, which has yielded to drainage and an improved water-supply, and now lingers in a few spots only, such as the Isle of Sheppey.

Dr. James Adam, in an article on disinfection by heat, points out that the germ-theory of infectious diseases, usually supposed to have been first devised by Pasteur, originated with Kircher 200 years ago, and was endorsed by Linnæus. Exposure to a temperature of from 212° to 230° F. is considered as sufficient for all practical purposes. It is, however, admitted that the spores of bacilli are destroyed only after being confined for three hours in a temperature of 284° F., and instances are recorded, apparently on the authority of Dr. Drysdale and Mr. Dallinger, of certain spores resisting for hours a temperature of 400° F.

An interesting paper, though unsatisfactory as regards its results, is that on the treatment of snake-poisoning, by Sir Joseph Fayrer, F.R.S. The conclusions of the author, based on very wide experience, are the reverse of hopeful. He said in 1868, and still is of opinion, that:—"To conceive of an antidote (as that term is usually understood) we must conceive of a substance so subtle as to follow, overtake, and neutralise the poison in the blood, and that shall have the power of counteracting or neutralising the poisonous and deadly influence it has exerted on vital force. Such a substance has still to be found, nor does our present experience of drugs give hopeful anticipation that we shall find it."

Lacerda, also, whilst maintaining the value of potassium permanganate as a chemical antidote where it can come in contact with the poison, admits that—"As to the idea of finding a physiological antidote for snake-poisoning, I entirely agree with you that it is a Utopia."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 5, August 4, 1884.

Reply to two Notes by M. Wroblewski.—L. Cailletet.—The author protests against the statements of Wroblewski that all attempts hitherto made to liquefy hydrogen had proved unsuccessful, and that he (Cailletet) admitted that the liquefaction of hydrogen was a problem still to be solved.

Influence of Temperature on the Hygroscopicity of Vegetable Earth.—T. Schlœsing.—The author gives his results in the form of a table.

New Apparatus for Collecting Carbon Dioxide in the "Snowy" State.—M. Ducretet.—The author's apparatus cannot be described intelligibly without the aid of the accompanying illustration.

Constitution of Certain Elementary Compounds of Cyanogen.—G. Calmels.—There are cyanides and isocyanides amongst the most simple derivatives of cyanogen, and their constitution is manifested by the fact that among the alkaline cyanides the radicle is fixed upon the carbon, whilst in those of the heavier metals it is fixed upon nitrogen.

On a Filter yielding Water Physiologically Pure.—C. Chamberland.—The author filters water through a

porous vessel of unglazed porcelain, and obtains it absolutely free from microbia. A single such vessel, 0·20 metre long, by 0·025 metre in diameter, yields about 20 litres of water daily.

The Decomposition of White Cast-iron by Heat.—L. Forquignon.—Cast-iron, if heated for several days to about 900° to 1000°, neither melts nor softens, but is converted into malleable iron. Its surface is covered with a greyish efflorescence. The fracture is sometimes of a uniform black, like that of a lead pencil, and sometimes riddled with large black points, regularly distributed in the metallic paste.

The Composition and Qualities of Coal with reference to the Plants which form it.—Ad. Carnot.—The author's experiments show that when all other circumstances are alike different species of plants have given rise to coals of decidedly different properties.

Calcium Oxy-chloride and the Calcium Silicates, Simple and Chlorinated. Artificial Production of Wollastonite.—Alex. Gorgen.—Both chemically, physically, and optically, the artificial wollastonite is identical with the natural mineral.

No. 6, August 11, 1884.

On Globular Lightning.—Gaston Planté.—This paper requires the two accompanying illustrations.

Certain Combinations formed by the Haloid Salts and the Oxy-salts of the same Metal.—H. Le Chatelier.—The author describes the calcium chloro-borate and chloro-ferrite.

Moniteur Scientifique, Quesneville.
Vol. xiv., August, 1884.

Patents Referring to Colouring Matters.—A list of German specifications. Especial mention may be made of the processes of H. Loder, of Amsterdam, who prepares colouring matters by the action of a solution of sugar in alcoholic fermentation on certain aromatic combinations. One of these mixtures consists of resorcine, orcene, saltpetre, and tartaric acid, added to the fermenting solution of sugar.

Synthesis of Xanthine.—A. Gauthier.—The author heats a mixture of dilute hydrocyanic acid and acetic acid to 140° to 150° in sealed tubes. The products are xanthine and methyl-xanthine.

Bulletin de la Société Chimique de Paris.
No. 2, 1884.

Chemical Reactions which accompany the Setting of Hydraulic Mortars.—H. Le Chatelier.—This memoir does not admit of useful abstraction.

Critical Observations on the Use of Gypsum Filters for Sterilising Liquids containing Ferments.—P. Cazeneuve.—The author shows that this method of filtration is open to certain objections. It keeps back soluble ferments and a very considerable proportion of the albumenoid matters. Hence, *e.g.*, blood thus treated is not merely deprived of living organisms, which may have been present, but undergoes other changes.

Action of Acetyl Chloride upon Toluene in Presence of Aluminium Chloride.—J. Ch. Essner and E. Gassin.—The authors obtained a yield of acetyl-toluol not exceeding 10 per cent of the theoretical quantity.

Constitution of the Pyridic Bases derived from Brucine.—Oechsner de Coninck.—An examination of two lutidines obtained from the crude quinoleine derived from brucine.

Action of Cyanogen upon Certain Ortho-diamines.—J. A. Bladin.—Cyanogen unites with the aromatic ortho-diamines forming compounds $C_nH_{2n-8}N_4$ ($n=8$, 9, &c.), which are in general more stable than the compounds of cyanogen with the monamines. They are very energetic bases which yield with acids two series of salts, containing 1 and 2 mols. of a mono-basic acid. The salts with 2 mols. of acid are unstable and lose 1 mol. of acid in contact with water.

Mono-chloric Ethyl-benzine.—M. Istrati.—Not suitable for abstraction.

Synthesis of Pyridic Hydrides.—Oechsner de Coninck.—The author has effected the synthesis of certain hexa-hydrides which are violent poisons producing symptoms analogous to those known by physiologists under the name of cicutism.

Journal für Praktische Chemie.
New Series, Vol. xxix., Part 6.

On Para-ethoxy-phenyl-urethan and some of its Derivatives.—H. Kœhler.—We have here an account of para-ethoxy-carbanil, nitro-para-ethoxy-phenyl-urethan, amido-para-ethoxy-phenyl-urethan hydrochlorate, non-symmetric ortho-diamido-phenol hydrochlorate, diazo-imid-ethoxy-phenyl-urethan, dinitro-para-ethoxy-phenyl-urethan, a second compound of the same name, diamido-para-ethoxy-phenyl-urethan hydrochlorate, trinitro-para-ethoxy-phenyl-urethan, triamido-para-ethoxy-phenyl-urethan hydrochlorate, trinitro-amido-phenetol, and tetra-amido-phenetol hydrochlorate.

The Action of Mono-chloracetic Acids upon Ortho- and Paramido-phenetol, and on the Oxyphenyl Glycines.—Heinrich Vater.—Like the amidic acids of the fatty series, and like tyrosine, the solutions of the oxyphenyl glycines are coloured blood-red by a drop of the solution of ferric chloride. The para-compounds form here no exception. The alkylised compounds show the same reaction. Whilst the amido-acids examined by Hofmeister give a blue colour with copper sulphate, the oxyphenyl glycines and their derivatives display a green colour. In the presence of sodium hydrate the amido-acids of the fatty series (except taurine) and tyrosine dissolve copper hydroxide. The oxyphenyl glycines form a light greenish yellow coagulum, which is converted into a voluminous yellow mass (slowly in the cold, but quickly on boiling) containing organic matter in addition to copper. With mercury salts there is no difference in the behaviour of the oxyphenyl glycines and the remaining amido-acids.

On Meta-azo- and Hydrazo-phenetol.—M. Buchstab—A preliminary communication.

New Formation of Carbostyril.—J. Rotheit.—Trichloroxy-chinoline is heated in sealed glass tubes with fuming hydriodic acid. At 250° it yields fine white needles of the composition of a carbostyril.

Action of Ethoxalyl-chloride upon Diphenyl-sulphurea and Triphenyl-guanidine.—M. v. Stojentin.—When ethoxalyl-chloride is cautiously allowed to act upon diphenyl-sulphurea dissolved in benzol there is a violent reaction, and a compound, $C_{21}H_{17}N_3S_2O$, is formed. If the alcoholic solution of this body is treated with silver nitrate it is easily freed from sulphur, and from the filtrate there crystallises out diphenyl-parabanic acid.

On a New Metallic Radicle.—P. Schützenberger.—From the *Comptes Rendus*.

Vol. xxix., Part 7.

Studies on Blood.—H. Struve.—The author regards the hæmoglobine crystals as crystals of a colourless albumenoid substance which hitherto has not been obtained pure, but contaminated with small quantities of one or of several blood-pigments. He dissents from the view of Hoppe-Seyler that "hæmochromogen is formed from hæmoglobine as a single product of splitting up; whilst hæmatine is formed from hæmoglobine or hæmochromogen only by oxidation."

Communications from the Agricultural-Chemical Laboratory of the University of Königsberg.—H. Ritthausen.—We have here an account of melitose from cotton-seed; a notice of the occurrence of citric acid in the seeds of various leguminous plants; a proof of the occurrence of vicine in broad beans (*Vicia faba*); and a paper on the solubility of vegetable proteine substances in water containing hydrochloric acid.

The Thio-lactic and the Thio-dilactic Acids.—J. M. Lovén.—Contrary to the assertion of Schacht and Böttenger pure thio-dilactic acid is a well crystallised and distinctly characterised substance.

Action of Hydroxylamine and Ethylamine upon Komanic Acid.—H. Ost.—Hydroxylamine acts upon komanic acid similarly to ammonia. Ethylamine converts komanic acid quantitatively into a compound, $C_8H_9NO_3+\frac{1}{2}H_2O$, which the author views as the oxycarbon acid of an ethyl-pyridine.

"De Mortuis nil nisi bene, sed non nimis."—H. Kolbe.—A critique on some recent eulogiums on Dumas.

Neutral Salts of Didymium Oxide and on the Valence of Didymium.—A. Cossa.—From the *Comptes Rendus*.

Parts 9, 10, and 11.

Studies in Chemical Dynamics.—W. Ostwald.—In this paper the author treats of the inversion of cane-sugar.

Relation between Luteo- and Roseo-Salts.—S. M. Jörgensen.—The luteo- and roseo-salts represent each other perfectly, the former containing $2NH_3$ and the latter $2OH_2$.

Formation of Acid Amides from the Salts of Ammonium.—N. Menschutkin.—The isomerism of acids has an influence on the speed of amidation. The primary acids display the greatest rapidity; the secondary acids have a less rapidity and a higher temperature at the beginning of the process. The tertiary acids have the smallest rapidity,—a conclusion drawn from the behaviour of the aromatic acids. Formic acid shows the greatest initial rapidity of amidation. Formic acid displays the smallest limit of normal amidation. The isomerism of the acids (in the first place only the primary and secondary) has no influence on the limit of amidation.

Modification of the Rapidity of Certain Reactions in Connection with the Temperature.—N. Menschutkin. —This paper does not admit of useful abstraction.

Communications from the Agricultural-Chemical Laboratory of the University of Königsberg.—H. Ritthausen.—This paper discusses the composition of the albumenoid bodies of *Vicea faba* and *Phaseolus*, as obtained by means of saline solutions.

Solubility of Solid Bodies in Water at different Temperatures.—Dr. J. L. Andreæ.—The author calls attention to several causes of error in the determination of solubilities. The ordinary methods of preparing saturated solutions are that either an excess of the salt is introduced into water at a constant temperature, stirring from time to time, or the water is saturated with the salt at a higher temperature, and the solution is let cool down to the temperature required, at which it is kept for some time with occasional agitation. The first method is apt to give too low and the second too high results. The author recommends that the mixture of salt and water should be kept in incessant agitation for one to one and a half hours. A second source of error lies in the determination of the temperature. The determination of the salt in the saturated solution is generally effected by evaporating a weighed portion to dryness and weighing the residue. If this evaporation is effected at a boil a part of the salt is lost. The purity of the salt employed necessarily affects the results. The author's method of experimentation cannot be explained without the accompanying illustrations.

Influence of Dilution upon the Rapidity of Chemical Reactions.—Waldemar de la Croix.—The author gives his results in the form of tables.

Apparatus for Determining Carbonic Acid and Carbonates.—Prof. R. Baur.—The apparatus cannot be intelligibly described without the illustration.

Anthology of Neo-chemical Utterances.—(Communicated by H. Kolbe).—The utterances in question are to be found in Prof. Baeyer's treatise on the "Combinations of the Indigo-group" (*Berichte Chem. Gesellschaft Berlin*, 1883, p. 2188).

Adolf Baeyer, the Reformer of Chemical Nomenclature.—H. Kolbe.—As specimens of the new nomenclature may be quoted "esotrichlor-exodichlor ethyl benzol; ex-brom-2-3-4 trichlor-cinnamic acid; B-oxy-Py-oxy-ex-oxychinolin cinnamic acid; w brom-4-brom-acetophenon."

Justus Liebig's Annalen der Chemie, Vol. 224, Parts 1 and 2.

On the Acridines.—A. Bernthsen.—In this extensive memoir the author has studied true acridine, obtained from formic acid and diphenylamine, phenyl-acridine, from benzoic acid and diphenylamine; methyl-acridine from acetic acid and diphenylamine; butyl-acridine, from valerianic acid and diphenylamine; and acridyl-benzoic acid, from phthalic acid and diphenylamine.

Researches on the Specific Volumes of Liquid Compounds.—This section (iv.) is a paper by Alb. Zander on the normal fatty acids and the normal fatty alcohols.

Communications from the Main Chemical Laboratory of the University of Tubingen.—These consist of a memoir by G. Kumpf on nitrised phenyl benzyl-ethers, a paper by P. Frische on nitrised para-kresyl-benzyl-ether, and one by M. Rapp on the phenyl- and kresyl-esters of phosphoric acid and their nitration.

Communications from the Chemical Laboratory of the University of Jena.—These papers are a continuation of the researches on sulphur compounds noticed in the last volume, and consist of memoirs by A. Geuther, on calcium oxy-suiphides, on the constitution of poly-sulphides and poly-oxides, and on certain compounds of sulphurous acid.

MISCELLANEOUS.

Gas-tight India-rubber Tubing.—An elastic rubber tubing perfectly gas-tight and free from smell has been urgently needed for many years; in fact, the impossibility of making satisfactory gas connection for gas apparatus which requires to be movable has rendered the use of gas as a fuel in many cases a most objectionable nuisance. A tubing recently brought out by Mr. Fletcher, of Warrington, is made of two layers of rubber, with pure soft tin-foil vulcanised between. It is said to be perfectly and permanently gas-tight under any pressure, and free from smell after long-continued use, whilst it retains the flexibility and elasticity of an ordinary rubber tube. The braided or cloth covered tube, which has been made with the intention of filling this want, has never come into general use owing to the very small quantity it passes, rendering it almost useless except for small lighting burners, and also that special brass connections and screws have to be fitted to every burner and to both ends of every length of tube: both these faults are entirely done away with. This tube fills a want which every user of gas apparatus must feel daily. Mr. Fletcher informs us that this tube has been in practical use for some time, and has been thoroughly tested for months under continuous and heavy pressures of gas.

NOTICE.

The STUDENTS' NUMBER of the CHEMICAL NEWS *will be published on Friday, September 19th. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

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LIFE AND WORKS

OF

THOMAS GRAHAM, D.C.L., F.R.S.,

Illustrated by Portrait, 64 Unpublished Letters, and Abstracts of all his Published Papers: prepared for the Graham Lecture Committee of the Glasgow Philosophical Society

BY

Dr. R. ANGUS SMITH, LL.D., F.R.S.

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THE CHEMICAL NEWS.

VOL. L. No. 1294.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION.

By Professor Sir WILLIAM THOMSON, M.A., LL.D., D.C.L., F.R.S. L. & E., F.R.A.S., President of the Section.

Steps towards a Kinetic Theory of Matter.

THE now well-known kinetic theory of gases is a step so important in the way of explaining seemingly static properties of matter by motion, that it is scarcely possible to help anticipating in idea the arrival at a complete theory of matter, in which all its properties will be seen to be merely attributes of motion. If we are to look for the origin of this idea, we must go back to Democritus, Epicurus, and Lucretius. We may then, I believe, without missing a single step, skip 1800 years. Early last century we find in Malebranche's "Recherche de la Verité," the statement that "La dureté des corps" depends on "petits tourbillons."* These words, embedded in a hopeless mass of unintelligible statements of the physical, metaphysical, and theological philosophies of the day, and unsupported by any explanation, elucidation, or illustration throughout the rest of the three volumes, and only marred by any other single sentence or word to be found in the great book, still do express a distinct conception, which forms a most remarkable step towards the kinetic theory of matter. A little later we have Daniel Bernoulli's promulgation of what we now accept as a surest article of scientific faith—the kinetic theory of gases. He, so far as I know, thought only of the Boyle's and Mariotte's law of the "spring of air," as Boyle called it, without reference to change of temperature or the augmentation of its pressure if not allowed to expand for elevation of temperature, a phenomenon which perhaps he scarcely knew, still less the elevation of temperature produced by compression, and the lowering of temperature by dilation, and the consequent necessity of waiting for a fraction of a second or a few seconds of time (with apparatus of ordinary experimental magnitude), to see a subsidence from a larger change of pressure, down to the amount of change that verifies Boyle's law. The consideration of these phenomena forty years ago by Joule, in connection with Bernoulli's original conception, formed the foundation of the kinetic theory of gases as we now have it. But what a splendid and useful building has been placed on this foundation by Clausius and Maxwell, and what a beautiful ornament we see on the top of it in the radiometer of Crookes, securely attached to it by the happy discovery of Tait and Dewar,† that the length of the free path of the residual molecules of air in a good modern vacuum may amount to several inches. Clausius's and Maxwell's explanations of the diffusion of gases, and of thermal conduction in gases, their charmingly intelligible conclusion that in gases the diffusion of heat is just a little more rapid than the diffusion of molecules, because of the interchange of energy in collisions between molecules,‡ while the chief transference of heat is by actual transport of the molecules themselves; and Maxwell's explanation of the viscosity of gases, with the absolute numerical relations which the work of those two great discoverers found among the three properties of diffusion, thermal conduction, and viscosity, have annexed to the domain of science a vast and ever-growing province.

Rich as it is in practical results, the kinetic theory of gases, as hitherto developed, stops absolutely short at the atom or molecule, and gives not even a suggestion towards explaining the properties in virtue of which the atoms or molecules mutually influence one another. For some guidance towards a deeper and more comprehensive theory of matter, we may look back with advantage to the end of last century and the beginning of this century, and find Rumford's conclusion regarding the heat generated in boring a brass gun: "It appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in these experiments, except it be MOTION," and Davy's still more suggestive statement: "The phenomena of repulsion are not dependent on a peculiar elastic fluid for their existence. . . ." "Heat may be defined a peculiar motion, probably a vibration, of the corpuscles of bodies, tending to separate them. . . ." "To distinguish this motion from others, and to signify the causes of our sensations of heat, &c., the name *repulsive* motion has been adopted." Here we have a most important idea. It would be somewhat a bold figure of speech to say the earth and moon are kept apart by a repulsive motion; and yet, after all, what is centrifugal force but a repulsive motion, and may it not be that there is no such thing as repulsion, and that it is solely by inertia that what seems to be repulsion is produced? Two bodies fly together, and, accelerated by mutual attraction, if they do not precisely hit one another, they cannot but separate in virtue of the inertia of their masses. So, after dashing past one another in sharply concave curves round their common centre of gravity, they fly asunder again. A careless onlooker might imagine they had repelled one another, and might not notice the difference between what he actually sees and what he would see if the two bodies had been projected with great velocity towards one another, and either colliding and rebounding, or repelling one another into sharply convex continuous curves, fly asunder again.

Joule, Clausius, and Maxwell, and no doubt Daniel Bernoulli himself, and I believe every one who has hitherto written or done anything very explicit in the kinetic theory of gases, has taken the mutual action of molecules in collision as repulsive. May it not after all be attractive? This idea has never left my mind since I first read Davy's "Repulsive Motion," about thirty-five years ago, but I never made anything of it, at all events have not done so until to-day (June 16, 1884), (if this can be said to be making anything of it), when in endeavouring to prepare the present address I notice that Joule's and my own old experiments* on the thermal effect of gases expanding from a high pressure vessel through a porous plug, proves the less dense gas to have greater intrinsic *potential* energy than the denser gas, if we assume the ordinary hypothesis regarding the temperature of a gas, according to which

* "Preuve de la supposition que j'ay faite: Que la matière subtile ou éthérée est nécessairement composée de PETITS TOURBILLONS; et qu'ils sont les causes naturelles de tous les changements qui arrivent à la matière; ce que je confirme par l'explication des effets les plus généraux de la Physique, tels que sont la dureté des corps, leur fluidité, leur pesanteur, leur legèreté, la lumiere et la réfraction et réflexion de ses rayons."—*Malebranche, Recherche de la Verité*, 1712.

† *Proc. R. S. E.* March 2, 1874, and July 5, 1875.

‡ On the other hand in liquids, on account of the crowdedness of the molecules, the diffusion of heat must be chiefly by interchange of energies between the molecules, and should be, as experiment proves it is, enormously more rapid than the diffusion of the molecules themselves, and this again ought to be much less rapid than either the material or thermal diffusivities of gases. Thus the diffusivity of common salt through water was found by Fick to be as small as 0·0000112 square centimetres per second: nearly 200 times as great as this is the diffusivity of heat through water, which was found by J. T. Bottomley to be about 0·002 square centimetres per second. The material diffusivities of gases, according to Loschmidt's experiments, range from 0·098 (the interdiffusivity of carbonic acid and nitrous oxide) to 0·642 (the interdiffusivity of carbonic oxide and hydrogen); while the thermal diffusivities of gases, calculated according to Clausius's and Maxwell's kinetic theory of gases, are 0·069 for carbonic acid, 0·16 for common air or other gases of nearly the same density, and 1·12 for hydrogen (all, both material and thermal, being reckoned in square centimetres per second).

* Republished in Sir W. Thomson's "Mathematical and Physical Papers," Vol I., Article xlix., p. 381.

two gases are of equal temperatures* when the kinetic energies of their constituent molecules are of equal average amounts per molecule.

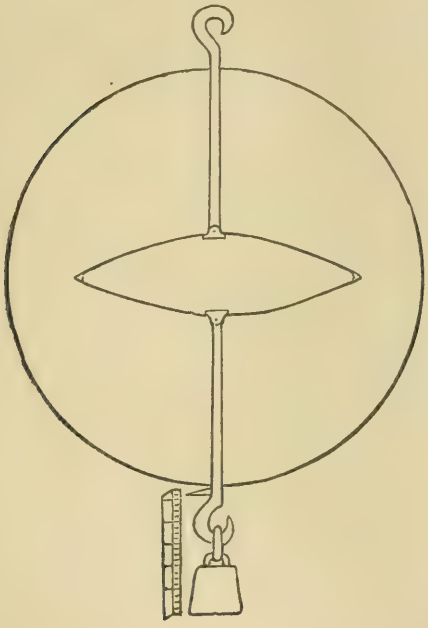
Think of the thing thus. Imagine a great multidude of particles enclosed by a boundary which may be pushed inwards in any part all round at pleasure. Now station an engineer corps of Maxwell's army of sorting demons all round the enclosure, with orders to push in the boundary diligently everywhere, when none of the besieged troops are near, and to do nothing when any of them are seen approaching, and until after they have turned again inwards. The result will be that with exactly the same sum of kinetic and potential energies of the same enclosed multidude of particles, the throng has been caused to be denser. Now Joule's and my own old experiments on the efflux of air prove that if the crowd be common air, or oxygen, or nitrogen, or carbonic acid, the temperature is a little higher in the denser than in the rarer condition when the energies are the same. By the hypothesis, equality of temperature between two different gases or two portions of the same gas at different densities means equality of kinetic energies in the same number of molecules of the two. From our observations proving the temperature to be higher, it therefore follows that the potential energy is smaller in the condensed crowd. This—always, however, under protest as to the temperature hypothesis—proves some degree of attraction among the molecules, but it does not prove ultimate attraction between two molecules in collision, or at distances much less than the average mutual distance of nearest neighbours in the multitude. The collisional force might be repulsive, as generally supposed hitherto, and yet attraction might predominate in the whole reckoning of difference between the intrinsic potential energies of the more dense and less dense multitudes. It is, however, remarkable that the explanation of the propagation of sound through gases, and even of the positive fluid pressure of a gas against the sides of the containing vessel, according to the kinetic theory of gases, is quite independent of the question whether the ultimate collisional force is attractive or repulsive. Of course it must be understood that if it is attractive, the particles must be so small that they hardly ever meet—they would have to be infinitely small to *never* meet—that, in fact, they meet so seldom, in comparison with the number of times their courses are turned through large angles by attraction, that the influence of these purely attractive collisions is preponderant over that of the comparitively very rare impacts from actual contact. Thus, after all, the train of speculation suggested by Davy's "Repulsive Motion" does not allow us to escape from the idea of true repulsion, does not do more than let us say it is of no consequence, nor even say this with truth, because, if there are impacts at all, the nature of the force during the impact, and the effects of the mutual impacts, however rare, cannot be evaded in any attempt to realise a conception of the kinetic theory of gases. And in fact, unless we are satisfied to imagine the atoms of a gas as mathematical points endowed with inertia, and, as according to Boscovich, endowed with forces of mutual positive and negative attraction, varying according to some definite function of the distance, we cannot avoid the question of impacts, and of vibrations and rotations of the molecules resulting from impacts, and we must look distinctly on each molecule as being either a little elastic solid, or a configuration of motion in a continuous all-pervading liquid. I do not myself see how we can ever permanently rest anywhere short of this last view; but it would be a very pleasant temporary resting-place on the way to it, if we could, as it were, make a mechanical model of a gas out of little pieces of round, perfectly elastic solid matter, flying about through the space occupied by the gas, and colliding with one another and against the sides of the containing vessel. This is, in fact, all we have of the kinetic theory of gases up to the present time, and this has done for us, in the hands of Clausius and Maxwell, the great things which constitute our first step towards a molecular theory of matter. Of course from it we should have to go on to find an explanation of the elasticity and all the other properties of the molecules themselves, a subject vastly more complex and difficult than the gaseous properties, for the explanation of which we assume the elastic molecule; but without any explanation of the properties of the molecule itself, with merely the assumption that the molecule has the requisite properties, we might rest happy for awhile in the contemplation of the kinetic theory of gases, and its explanation of the gaseous properties, which is not only stupendously important as a step towards a more thorough-going theory of matter, but is undoubtedly the expression of a perfectly intelligible and definite set of facts in nature. But alas for our mechanical model consisting of the cloud of little elastic solids flying about amongst one another. Though each particle have absolutely perfect elasticity, the end must be pretty much the same as if it were but imperfectly elastic. The average effect of repeated and repeated mutual collisions must be to gradually convert all the translational energy into energy of shriller and shriller vibrations of the molecule. It seems certain that each collision must have something more of energy in vibrations of very finely divided nodal parts than there was of energy of such vibrations before the impact. The more minute this nodal subdivision, the less must be the tendency to give up part of the vibrational energy into the shape of translational energy in the course of a collision, and I think it is rigorously demonstrable that the whole translational energy must ultimately become transformed into vibrational energy of higher and higher nodal subdivisions if each molecule is a continuous elastic solid. Let us, then, leave the kinetic theory of gases for a time with this difficulty unsolved, in the hope that we or others after us may return to it, armed with more knowledge of the properties of matter, and with sharper mathematical weapons to cut through the barrier which at present hides from us any view of the molecule itself, and of the effects other than mere change of translational motion which it experiences in collision.

To explain the elasticity of a gas was the primary object of the kinetic theory of gases. This object is only attainable by the assumption of an elasticity more complex in character, and more difficult of explanation, than the elasticity of gases—the elasticity of a solid. Thus, even if the fatal fault in the theory, to which I have alluded, did not exist, and if we could be perfectly satisfied with the kinetic theory of gases founded on the collisisns of elastic solid molecules, there would still be beyond it a grander theory which need not be considered a chimerical object of scientific ambition—to explain the elasticity of solids. But we may be stopped when we commence to look in the direction of such a theory with the cynical question: What do you mean by explaining a property of matter? As to being stopped by any such question, all I can say is that if engineering were to be all and to end all physical science, we should perforce be content with merely finding properties of matter by observation, and using them for practical purposes. But I am sure very few, if any, engineers are practically satisfied with so narrow a view of their noble profession. They must and do patiently observe, and discover by observation, properties of matter, and results of material combinations. But deeper questions are always present, and always fraught with interest to the true engineer, and he will be the last to give weight to any other objection to any attempt to see below the surface of things than the

* That this is a mere hypothesis has been scarcely remarked by the founders themselves, nor by almost any writer on the kinetic theory of gases. No one has yet examined the question: what is the condition as regards average distribution of kinetic energy, which is ultimately fulfilled by two portions of gasous matter, separated by a thin elastic septum which absolutely prevents interdiffusion of matter, while it allows interchange of kinetic energy by collisions against itself? Indeed I do not know but that the present is the very first statement which has ever been published of this condition of the problem of equal temperatures between two gaseous masses.

practical question: Is it likely to prove wholly futile? But now instead of imagining the question: What do you mean by explaining a property of matter? to be put cynically, and letting ourselves be irritated by it, suppose we give to the questioner credit for being sympathetic, and condescend to try and answer his question. We find it not very easy to do so. All the properties of matter are so connected that we can scarcely imagine one *thoroughly explained* without our seeing its relation to all the others, without in fact having the explanation of all, and till we have this we cannot tell what we mean by "explaining a property," or "explaining the properties" of matter. But though this consummation may never be reached by man, the progress of science may be, I believe will be, step by step towards it, on many different roads converging towards it from all sides. The kinetic theory of gases is, as I have said, a true step on one of the roads. On the very distinct road of chemical science, Ste.-Claire Deville arrived at his grand theory of dissociation without the slightest aid from the kinetic theory of gases. The fact that he worked it out solely from chemical observation

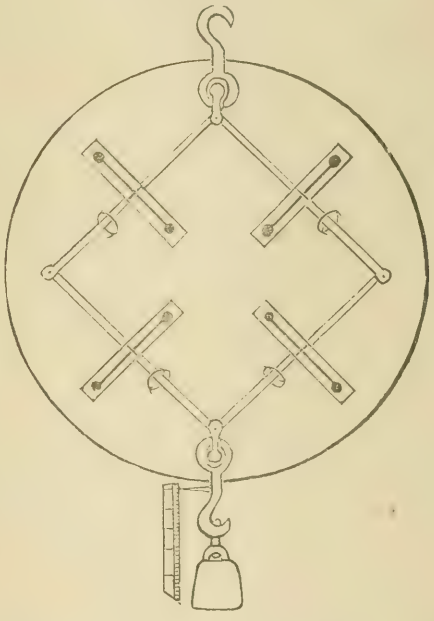
Fig. 1.



and experiment, and expounded it to the world without any hypothesis whatever, and seemingly even without consciousness of the beautiful explanation it has in the kinetic theory of gases, secured for it immediately an independent solidity and importance as a chemical theory when he first promulgated it, to which it might even by this time scarcely have attained if it had first been suggested as a probability indicated by the kinetic theory of gases, and been only afterwards confirmed by observation. Now, however, guided by the views which Clausius and Williamson have given us of the continuous interchange of partners between compound molecules constituting chemical compounds in the gaseous state, we see in Deville's theory of dissociation a point of contact of the most transcendent interest between the chemical and physical lines of scientific progress.

To return to elasticity: if we could make out of matter devoid of elasticity a combined system of relatively moving parts which, in virtue of motion, has the essential characteristics of an elastic body, this would surely be, if not positively a step in the kinetic theory of matter, at least a finger-post pointing a way which we may hope will lead to a kinetic theory of matter. Now this, as I have already shown,* we can do in several ways. In the case of the last of the communications referred to, of which only the title has hitherto been published, I showed that, from the mathematical investigation of a gyrostatically dominated combination contained in the passage of Thomson and Tait's "Natural Philosophy" referred to, it follows that any ideal system of material particles, acting on one another mutually through massless connecting springs, may be perfectly imitated in a model consisting of rigid links jointed together, and having rapidly rotating fly-wheels pivoted on some or on all of the links. The imitation is not confined to cases of equilibrium. It holds also for vibration produced by disturbing the system infinitesimally from a position of stable equilibrium and leaving it to itself. Thus we may make a gyrostatic system such that it is in equilibrium under the influence of certain positive forces applied to different points of this system; all the forces being precisely the same as, and the points of application similarly situated to, those of the stable system with springs. Then, provided proper masses (that

Fig. 2.



is to say, proper amounts and distributions of inertia) be attributed to the links, we may remove the external forces from each system, and the consequent vibration of the points of application of the forces will be identical. Or we may act upon the systems of material points and springs with any given forces for any given time, and leave it to itself, and do the same thing for the gyrostatic system; the consequent motion will be the same in the two cases. If in the one case the springs are made more and more stiff, and in the other case the angular velocities of the fly-wheels are made greater and greater, the periods of the vibrational constituents of the motion will become shorter and shorter, and the amplitudes smaller and smaller, and the motions will approach more and more nearly those of two perfectly rigid groups of material points, moving through space and rotating according to the well-known mode of rotation of a rigid body having

* Paper on "Vortex Atoms," *Proc. R. S. E.*, Feb., 1867; abstract of Lecture before Royal Institution of Great Britain, March 4, 1881, on "Elasticity viewed as possibly a Mode of Motion"; Thomson and Tait's "Natural Philosophy," second edition, Part I., §§ 345 viii. to 345 xxvii.; "On Oscillation and Waves in an Adynamic Gyrostatic System" (title only), *Proc. R. S. E.*, March, 1883.

unequal moments of inertia about its three principal axes. In one case the ideal nearly rigid connection between the particles is produced by massless exceedingly stiff springs; in the other case it is produced by the exceedingly rapid rotation of the fly wheels in a system which, when the fly-wheels are deprived of their rotation, is perfectly limp.

The drawings (Figs. 1 and 2) before you illustrate two such material systems.* The directions of rotation of the fly-wheels in the gyrostatic system (Fig. 2) are indicated by directional elipses, which show in perspective the direction of rotation of the fly-wheel of each gyrostat. The gyrostatic system (Fig. 2) might have been constituted of two gyrostatic members, but four are shown for symmetry. The enclosing circle represents in each case in section an enclosing spherical shell to prevent the interior from being seen. In the inside of one there are fly-wheels, in the inside of the other a massless spring. The projecting hooked rods seem as if they are connected by a spring in each case. If we hang any one of the systems up by the hook on one of its projecting rods, and hang a weight to the hook of the other projecting rod, the weight when first put on will oscillate up and down, and will go on doing so for ever if the system be absolutely unfrictional. If we check the vibration by hand, the weight will hang down at rest, the pin drawn out to a certain degree; and the distance drawn out will be simply proportional to the weight hung on, as in an ordinary spring balance.

Here, then, out of matter possessing rigidity, but absolutely devoid of elasticity, we have made a perfect model of a spring in the form of a spring balance. Connect millions and millions of particles by pairs of rods such as these of this spring balance, and we have a group of particles constituting an elastic solid; exactly fulfilling the mathematical ideal worked out by Navier, Poisson, and Cauchy, and many other mathematicians who, following their example, have endeavoured to found a theory of elasticity of solids on mutual attraction and repulsion between a group of material particles. All that can possibly be done by this theory, with its assumption of forces acting according to any assumed law of relation to distance, *is* done by the gyrostatic system. But the gyrostatic system does, besides, what the system of naturally acting material particles cannot do: it constitutes an elastic solid which can have the Faraday magneto-optic rotation of the plane of polarisation of light; supposing the application of our solid to be a model of the luminiferous ether for illustrating the undulatory theory of light. The gyrostatic model spring balance is arranged to have zero moment of momentum as a whole, and therefore to contribute nothing to the Faraday rotation; with this arrangement the model illustrates the luminiferous ether in a field unaffected by magnetic force. But now let there be a different rotational velocity imparted to the jointed square round the axis of the two projecting hooked rods, such as to give a resultant moment of momentum round any given line through the centre of inertia of the system, and let pairs of the hooked rods in the model thus altered, which is no longer a model of a mere spring-balance, be applied as connections between millions of pairs of particles as before: with the lines of resultant moment of momentum all similarly directed. We now have a model elastic solid which will have the property that the direction of vibration in waves of rectilinear vibrations propagated through it shall turn round the line of propagation of the waves; just as Faraday's observation proves to be done by the line of vibration of light in a dense medium between the poles of a powerful magnet. The case of wave front perpendicular to the lines of resultant moment of momentum (that is to say, the direction of propagation being parallel to these lines) corresponds, in our mechanical model, to the case of light travelling in the direction of the lines of force in a magnetic field.

In these illustrations and models we have different portions of ideal rigid matter acting upon one another, by normal pressure at mathematical points of contact—of course no forces of friction are supposed. It is exceedingly interested to see how thus, with no other postulates than inertia, rigidity, and mutual impenetrability, we can thoroughly model not only an elastic solid, and any combination of elastic solids, but so complex and recondite a phenomenon as the passage of polarised light through a magnetic field. But now, with the view of ultimately discarding the postulate of rigidity from all our materials, let us suppose some to be absolutely destitute of rigidity, and to possess merely inertia and incompressibility, and mutual impenetrability with reference to the still remaining rigid matter. With these postulates we can produce a perfect model of mutual action at a distance between solid particles, fulfiling the condition, so keenly desired by Newton and Faraday, of being explained by continuous action through an intervening medium. The law of the mutual force in our model, however, is not the simple Newtonian law, but the much more complex law of the mutual action between two electromagnets—with this difference, that in the hydrokinetic model in every case the force is opposite in direction to the corresponding force in the electro-magnetic analogue. Imagine a solid bored through with a hole and placed in our ideal perfect liquid. For a moment let the hole be stopped by a diaphragm, and let an impulsive pressure be applied for an instant uniformly over the whole membrane, and then instantly let the membrane be dissolved into liquid. This action originates a motion of the liquid relatively to the solid, of a kind to which I have given the name of "irrotational circulation," which remains absolutely constant however the solid be moved through the liquid. Thus, at any time the actual motion of the liquid at any point in the neighbourhood of the solid will be the resultant of the motion it would have in virtue of the circulation alone were the solid at rest, and the motion it would have in virtue of the motion of the solid itself, had there been no circulation established through the aperture. It is interesting and important to remark in passing that the whole kinetic energy of the liquid is the sum of the kinetic energies which it would have in the two cases separately. Now, imagine the whole liquid to be enclosed in an infinitely large rigid containing vessel, and in the liquid, at an infinite distance from any part of the containing vessel, let two perforated solids, with irrotational circulation through each, be placed at rest near one another. The resultant fluid motion due to the two circulations will give rise to fluid pressure on the two bodies, which if unbalanced will cause them to move. The force systems—force-and-torques, or pairs of forces—required to prevent them from moving will be mutual and opposite, and will be the same as, but opposite in direction to, the mutual force systems required to hold at rest two electro-magnets fulfilling the following specification. The two electro-magnets are to be of the same shape and size as the two bodies, and to be placed in the same relative positions, and to consist of infinitely thin layers of electric currents in the surfaces of solids possessing extreme diamagnetic quality—in other words, infinitely small permeability. The distribution of electric current on each body may be any whatever which fulfils the condition that the total current across any closed line drawn on the surface once through the aperture is equal to $1/4\pi$ of the circulation* through the aperture in the hydrokinetic analogue.

* In Fig. 1 the two hooked rods seen projecting from the sphere are connected by an elastic coach spring. In Fig. 2 the hooked rods are connected one to each of two opposite corners of a four-sided jointed frame, each member of which carries a gyrostat so that the axis of rotation of the fly-wheel is in the axis of the member of the frame which bears it. Each of the hooked rods in Fig. 2 is connected to the framework through a swivel joint, so that the whole gyrostatic framework may be rotated about the axis of the hooked rods in order to annul the moment of momentum of the framework about this axis due to rotation of the fly-wheels in the gyrostats.

* The integral of tangential component velocity all round any closed curve, passing once through the aperture, is defined as the "Cyclic constant," or the "circulation" ("Vortex Motion," § 60 (*a*) *Trans.*

It might be imagined that the action at a distance thus provided for by fluid motion could serve as a foundation for a theory of the equilibrium, and the vibrations, of elastic solids, and the transmission of waves like those of light through an extended quasi-elastic solid medium. But unfortunately for this idea the equilibrium is essentially unstable, both in the case of magnets and, notwithstanding the fact that the forces are oppositely directed, in the hydrokinetic analogue also, when the several movable bodies (two or any greater number) are so placed relatively as to be in equilibrium. If, however, we connect the perforated bodies with circulation through them in the hydrokinetic system, by jointed rigid connecting links, we may arrange for configurations of stable equilibrium. Thus without fly-wheels, but with fluid circulations through apertures, we may make a model spring balance, or a model luminiferous ether, either without or with the rotational quality corresponding to that of the true luminiferous ether in the magnetic fluid—in short, do all by the perforated solids with circulations through them that we saw we could do by means of linked gyrostats. But something that we cannot do by linked gyrostats we can do by the perforated bodies with fluid circulation. We can make a model gas. The mutual action at a distance, repulsive or attractive according to the mutual aspect of the two bodies when passing within collisional distance* of one another, suffices to produce the change of direction of motion in collision, which essentially constitutes the foundation of the kinetic theory of gases; and which, as we have seen before, may as well be due to attraction as to repulsion, so far as we know from any investigation hitherto made in this theory.

There remains, however, as we have seen before, the difficulty of providing for the case of actual impacts between the solids; which must be done by giving them massless spring buffers, or, which amounts to the same thing, attributing to them repulsive forces sufficiently powerful at very short distances to absolutely prevent impacts between solid and solid; unless we adopt the equally repugnant idea of infinitely small perforated solids, with infinitely great fluid circulations through them. Were it not for this fundamental difficulty, the hydrokinetic model gas would be exceedingly interesting; and, though we could scarcely adopt it as conceivably a true representation of what gases really are, it might still have some importance as a model configuration of solid and liquid matter, by which without elasticity the elasticity of a true gas might be represented.

But lastly, since the hydrokinetic model gas with perforated solids and fluid circulations through them fails because of the impacts between the solids, let us annul the solids and leave the liquid performing irrotational circulation round vacancy,† in the place of the solid cores which we have hitherto supposed; or let us annul the rigidity of the solid cores of the rings and give them molecular rotation according to Helmholtz's theory of vortex mation. For stability the molecular rotation must be such as to give the same velocity at the boundary of the rotational fluid core as that of the irrotationally circulating liquid in contact with it, because, as I have proved, frictional slip between two portions of liquid in contact is inconsistent with stability. There is a further condition, upon which I cannot enter in detail just now, but which may be understood in a general way when I say that it is a condition of either uniform or of increasing molecular rotation from the surface inwards, analogous to the condition that the density of a liquid, resting for example under the influence of gravity, must either be uniform or must be greater below than above for stability of equilibrium. All that I have said in favour of the model vortex gas composed of perforated solids with fluid circulations through them holds without modification for the purely hydrokinetic model, composed of either Helmholtz cored vortex rings or of coreless vortices, and we are now troubled with no such difficulty as that of the impacts between solids. Whether, however, when the vortex theory of gases is thoroughly worked out, it will or will not be found to fail in a manner analogous to the failure which I have already pointed out in connection with the kinetic theory of gases composed of little elastic solid molecules, I cannot at present undertake to speak with certainty. It seems to me most probable that the vortex theory cannot fail in any such way, because all I have been able to find out hitherto regarding the vibrations of vortices,* whether cored or coreless, does not seem to imply the liability of translational or impulsive energies of the individual vortices becoming lost in energy of smaller and smaller vibrations.

As a step towards kinetic theory of matter it is certainly most interesting to remark that in the quasi-elasticity, elasticity looking like that of an india-rubber band, which we see in a vibrating smoke-ring launched from an elliptic aperture, or in two smoke-rings which were circular, but which have become deformed from circularity by mutual collision, we have in reality a virtual elasticity in matter devoid of elasticity, and even devoid of rigidity, the virtual elasticity being due to motion, and generated by the generation of motion.

R. S. E., April 29, 1867). It has the same value for all closed curves passing just once through the aperture, and it remains constant through all time whether the solid body be in motion or at rest.

* According to this view there is no precise distance, or definite condition respecting the distance, between two molecules at which apparently they come to be in collision, or when receding from one another they cease to be in collision. It is convenient, however, in the kinetic theory of gases, to adopt arbitrarily a precise definition of collision, according to which two bodies or particles mutually acting at a distance may be said to be in collision when their mutual action exceeds some definite arbitrarily assigned limit, as, for example, when the radius of curvature of the path of either body is less than a stated fraction (1/100, for instance) of the distance between them.

† Investigations respecting coreless vortices will be found in a paper by the author, "Vibrations of a Columnar Vortex," *Proc. R.S.E.*, March 1, 1880; and a paper by Hicks, recently read before the Royal Society.

DETERMINATION OF WOOL, SILK, AND COTTON IN TISSUES.

By A. REMONT.

THE author takes four portions, weighing each 2 grms., puts one of them aside, and boils the remainder for a quarter of an hour in hydrochloric acid at 3 per cent. If after the lapse of this time the liquid is deeply coloured it is decanted, and fresh acid is added, in which the swatches are boiled for half-an-hour longer. Finally, they are washed in water, and wrung out in a linen cloth. This removes the dressing. The ebullition with dilute acid removes the dyes readily from cotton, less readily from wool, and very imperfectly from silk. Dark coloured silks are most heavily weighted. The iron compounds used for this purpose are completely removed by the process above described, if they do not exceed one-quarter of the total weight of the fibre, which has then a chesnut-brown colour. If the weighting is very heavy the material is only partially decolourised. In this case a few threads, after boiling, are incinerated; the weight of the residual ferric oxide is determined and taken into account if it exceeds 5 per cent.

One of the boiled swatches is laid aside, and the other two are plunged for one or two minutes into a boiling solution of basic zinc chloride at 60° B. (This reagent is prepared, according to Morin, by mixing together 1000 parts melted zinc chloride, 850 parts of distilled water, and 40 parts of zinc oxide, heating until the last-mentioned article is dissolved.) The swatches are allowed to drain, thrown into water, and thoroughly washed, first with acidulated water, and then with pure water. This opera-

* See papers by the author "On Vortex Motion," *Trans. R. S. E.*, April, 1867, and "Vortex Statics," *Proc. R. S. E.*, December, 1875; also a paper by J. J. Thomson, B.A., "On the Vibrations of Vortex Ring," *Trans. R. S.*, December, 1881, and his valuable book on Vortex Motion.

tion is accelerated by wringing out the swatches each time in a linen cloth. This operation removes the silk.

One of the two swatches from which the silk has thus been removed is put aside. The other is gently boiled for a quarter of an hour in 60 to 80 c.c. soda-lye at sp. gr. 1·020. If the boiling is too strong the lye may become so far concentrated as to attack vegetable fibre considerably. The swatch is washed as above, avoiding friction, as the fibres have been rendered brittle by the treatment which they have undergone.

All four swatches are then heated for fifteen minutes in distilled water, pressed, and allowed to lie in the same room in which they had been previously kept. The next day they are weighed. The swatch first laid aside should weigh 2 grms.; a difference of less than 5 milligrms. may be neglected, but a greater difference must be taken into account. The difference between the weight of this swatch and that of the second represents the dressing; that between the second and third gives the silk. The weight of the fourth swatch represents approximately the vegetable fibre present (cotton, phormium, flax, hemp), but it is somewhat attacked by the soda-lye. In cotton this loss has been found in a series of experiments to amount to 5 per cent. On multiplying the figures obtained by 50 we obtain the percentage of dressing silk and vegetable fibre. The remainder is the wool.—*Zeitschrift fur Analytische Chemie.*

ON THE CONNECTION BETWEEN PSEUDO SOLUTION AND TRUE SOLUTION.

By W. W. J. NICOL, M.A., B.Sc., F.R.S.E., F.C.S.,
Lecturer on Chemistry, Mason College, Birmingham.

It is well known that very finely divided solids are capable of remaining suspended in water for days, or weeks, or even months without any appreciable precipitation taking place. So long ago as 1827 Brown* observed that such fine particles exhibit a quivering or jumping motion—the so-called "Brownian" or "pedetic motion." By the exhaustive researches of Weber† and Wiener‡ it has been shown that this motion is *not* caused—

(*a*) By infusoria;
(*b*) By mechanical agitation communicated to the liquid;
(*c*) By the mutual attraction or repulsion of the particles themselves;
(*d*) By alterations of temperature;
(*e*) By evaporation.

And it is now very generally admitted that the motion of the particles is due to the impact of the molecules of the liquid on them, and that such motion is exhibited only by particles less than 0·0005 m.m. in diameter.

Still more recently it has been found|| that the amount and rapidity of this motion increases with the temperature of the liquid; and that the influence of the impact of the molecules of the liquid is sufficient to overcome the action of gravity even in the case of particles of heavy bodies in a specifically light liquid. For instance, particles of mercuric sulphide, of sufficiently small size, suspended in water, not only do not sink to the bottom of the vessel, but actually diffuse uniformly throughout the liquid. Small bubbles of various gases in soap solution also exhibit similar motions; and drops of oil or small particles of fat are known to remain long suspended in water, and to possess a motion in an inverse ratio to their size. Finally, when a solid body, in a fine state of division, remains suspended for an indefinite time in water, it is possible to bring about almost immediate precipitation by the addition of soluble substances to the water; thus, alum is well known to have a clearing effect on turbid water. The precipitate thus produced is found to consist of amorphous aggregations of particles which are destitute of motion.*

I wish briefly to point out the agreement of the observed facts with regard to pseudo solution with what may be called the molecular theory of solution† in contradistinction to the hydrate theory. According to this theory, solution of a salt in water is a consequence of the attraction of the water molecules for a single salt molecule, exceeding the attraction of the molecules of salt for one another. Thus the solubility or insolubility of a salt is conditioned largely by its cohesion; if the cohesion be great the solubility is small, and *vice versa*. Thus, in the case of barium sulphate the cohesion is very great, and the solubility almost *nil*; but if by mechanical or other means the cohesion be destroyed for a time—that is, if it be finely divided—then it will remain suspended in water for a very long time. Thus, although the water molecules of themselves are not able to overcome the cohesion of the salt, yet, when that is overcome by other means, they are able to retain the salt in pseudo solution, which differs from true solution only in the degree of division of the solid. If, therefore, it were possible to divide an insoluble body into its molecules, it would also be possible to dissolve it in water to a great extent, and separation from such a solution would go on exceedingly slowly, for only seldom would a sufficient number of the molecules of the solid be in contact at one time, so that their mutual attraction might exceed that of the water for them. Cases similar to this are very common: I may instance the extremely slow precipitation of many insoluble compounds from cold dilute solutions.

In conclusion, I have already pointed out,‡ in a paper on saturation, that if there be two salts, one very soluble in water and the other less so,—*e.g.*, $CaCl_2$ and NaCl—then if $CaCl_2$ be added to a solution of NaCl, this last salt is precipitated owing to the more soluble salt having a greater attraction for the molecules of water, a case analogous, I think, to the precipitation of fine mud from water on the addition of a soluble body. Colloidal silica and ferric hydrate are also precipitated on the addition of salt, but such cases are intermediate between pseudo and true solution.

R. Brown, 1827. Compare *Jahresberichte*, 1867, 11.
| Weber, *Pogg. Ann.*, 1854, xciv., 447.
‡ Wiener, *Pogg. Ann.*, cxviii., 85.
Exner, *Jahresberichte*, 1867, 12.

* See Naumann, "Thermo-chemie," 1882, p. 32.
† Nicol, *Phil. Mag.*, Feb., 1853, p. 91.
‡ *Phil. Mag.*, June, 1884, p. 547.
|| Read before the Birmingham Philosophical Society, June, 1884.

CHEMICAL ACTIONS WITH CARBON AND ITS COMPOUNDS.||

By G. GORE, LL.D., F.R.S.

The following experiments were made partly with the object of finding some new reactions in which carbon was set free in the elementary state, and also to discover new facts respecting carbon and some of its compounds:—

1. White phosphorus was added in very small fragments at a time to potassic cyanide in a state of fusion; strong effervescence occurred. On dissolving the cooled mass in water a small quantity of black matter was left. The black matter was insoluble in a hot mixture of nitric and hydrofluoric acids; it burned with a glow, without flame, and left hardly a trace of residue; it was therefore carbon, and may have been derived from potassic carbonate contained in the cyanide. (Compare experiments 2 and 3).

2. Red phosphorus in a state of powder, added to potassic cyanide in a state of fusion, produced strong action, and caused the cyanide to become black; and upon dissolving the cooled salt in water much black powder of low specific gravity separated. Powdered arsenic also caused the separation of a small amount of black

matter from the fused salt. Powdered antimony had a similar effect.

3. A mixture of pure potassic and sodic carbonates in a fused state was not visibly decomposed by metallic arsenic or antimony; but by aluminium carbon was separated.

4. When carbonate of sodium at a low red-heat was decomposed by vapour of phosphorus, if the residue was not finally heated so as to expel all free phosphorus, on subsequently dissolving it in water a dark brown liquid was obtained, the blackness of which could not be entirely removed even by a large number of successive filtrations. The black matter in the filter required extreme washing in order to obtain a colourless filtrate.

5. By adding phosphide of sodium to a fused mixture of the pure carbonates of sodium and potassium a little incandescence occurred, and a black coaly-looking substance was obtained. The cooled substance, on being thrown into water, evolved a very small amount of spontaneously inflammable gas. The experiment was repeated with the previous addition of zinc to the salt. In each case, on treating the residue with water, a black powder was obtained which burned readily and left no residue.

6. By projecting small portions of a mixture of red phosphorus and ammonic carbonate, each in a state of powder, into a red-hot porcelain crucible, fused phosphoric acid of a blackish colour was obtained.

7. No carbon was set free by adding ammonic carbonate to fused sodium in a wrought-iron cup; scintillation only took place when the carbonate touched the melted metal.

8. Metallic sodium was added to melted potassic cyanide; it floated, burned, and disappeared. On treating the cooled mass with water a minute quantity only of black matter separated.

9. A piece of potassium and a small quantity of bisulphide of carbon were highly heated in a lightly closed glass tube, and shaken. The glass became filled with green vapour of potassium, portions of the contents became red-hot, and the tube burst with a loud report.

10. Coal-gas was passed over red-hot peroxide of iron in a state of fine powder; it set free metallic iron and carbon as a fine black powder.

11. By passing coal-gas over fused argentic fluoride in a platinum boat at an incipient red-heat all the silver salt was reduced to metal, hydrofluoric acid was formed, and a little carbon was separated as a black powder mixed with the unfused silver.

12. Coal-gas was passed over argentic chloride just below its fusion-point, also over chloride of lead in a state of fusion, until the salts were quite reduced to metal. In each case, but most with the silver salt, carbon in the state of a fine black powder was set free, and was obtained on dissolving the residue in dilute nitric acid. The chlorides of copper and cadmium were similarly treated; the former was slowly reduced and some carbon liberated; the latter was not decomposed.

13. By passing coal-gas, during several hours, over fused iodide of silver in a glass retort, at a red-heat, only a comparatively small portion of the salt was reduced to the metallic state; no carbon was detected.

14. A mixture of tetrafluoride of silicon and carbonic anhydride was passed through a red-hot glass tube. No silica was produced nor carbon set free. By passing also a mixture of carbonic anhydride, phosphuretted hydrogen, and vapour of carbonate of ammonium through a similarly heated tube, no carbon was liberated.

15. Mixtures of carbonic anhydride and hydrogen, carbonic oxide and hydrogen, and of all three of these gases, were passed through red-hot glass tubes, and also over red-hot platinum-foil, but in no case was either vapour of water formed or carbon eliminated. By passing a mixture of carbonic anhydride and hydrogen through a red-hot iron tube containing iron turnings, no decomposition occurred.

16. No carbon was liberated by long-continued contact of carbonic anhydride gas with a solution of white phosphorus in carbonic bisulphide. Pieces of white phosphorus in water exposed to an atmosphere of carbonic anhydride in a dark place, during nine weeks, showed no signs of change.

17. Silicon in contact with pure gold in water exposed to carbonic anhydride showed no visible change in six weeks. With vapour of CCl_4, instead of carbonic anhydride, the results were the same. With magnesium in absolute alcohol exposed to carbonic anhydride gas, no carbon was liberated.

18. By condensing carbonic anhydride in the liquid state at 60° F. into contact with potassium and sodium, no carbon was set free.

19. By passing vapour of selenium slowly over a layer of charcoal powder, 8 inches long, in a thick refractory glass tube, at a full red-heat during one hour and a half, about three drops of a liquid were obtained. Several experiments of this kind were made, and in one of them the liquid dissolved some of the selenium, and formed a thick oil, of a red-brown colour.

20. Potassium which had been kept immersed in excess of liquid C_2Cl_4 in a closely stoppered bottle during four years, became wholly converted into a soluble white salt of strongly alkaline reaction. No carbon was separated.

21. By bringing into contact either of the four chlorides of carbon, bromide of carbon, carbonic bisulphide, pure anhydrous carbonate, or formiate of sodium, or ammonic oxalate, with a deep blue solution of potassium or sodium in anhydrous liquid ammonia under pressure at 60° F., chemical changes occurred: the liquid was decolourised, soluble salts were formed, but no carbon was liberated in either of the instances.

22. By passing dry ammonia gas through liquid C_2Cl_2 containing potassium, gas was caused to evolve from the surface of the metal, and a red powder was precipitated. By using Persian naphtha instead of the chloride of carbon some ammonia was dissolved, and the potassium only became red on its surface. Potassium in amylene evolved gas freely.

23. Lampblack, also well-burned wood charcoal, was insoluble in anhydrous liquefied cyanogen, but the chlorides and sulphide of carbon were freely soluble. Lampblack was also insoluble in liquid chloride of sulphur, terchloride of phosphorus, or boiling penta-chloride of antimony.

24. Carbon was not consumed by being heated to redness in contact with argentic fluoride; if, however, chlorine was present, the carbon disappeared.

25. By experiment I found that carbon was insoluble in anhydrous hydrofluoric acid at 32° F.; also in anhydrous hydrochloric acid, or carbonic acid, each in the liquefied state under great pressure at 60° F. Carbon which had been reduced from vaporous carbonic bisulphide by means of red-hot potassium or sodium, dissolved slightly in boiling nitric acid, and formed a brownish liquid.

26. Neither carbonic bisulphide nor either of the chlorides of carbon would dissolve in, or unite with, liquefied anhydrous hydrofluoric acid, nor was either of the four chlorides of carbon perceptibly soluble in concentrated hydrochloric acid.

27. A vessel filled with carbonic anhydride was inverted over strong aqueous hydrofluoric acid at 60° F., during thirty-six hours; scarcely any of the gas was absorbed.

28. A saturated solution of sulphur in bisulphide of carbon, also one of phosphorus in that liquid, were each enclosed in separate glass globes filled with carbonic anhydride, and kept in the dark during two months. No signs of any chemical change took place.

29. A thin wire of platinum was twisted round a thick one of pure tin, and immersed in purified carbonic bisulphide during nine weeks. No visible change occurred. This is a process which some one had published as an artificial one for producing diamonds.

30. In carbonic bisulphide, silver in contact with platinum

became quite black in three weeks. Magnesium in contact with that metal was unaffected in ten weeks. Lead in contact with mercury during two years formed a black powder which was entirely soluble in dilute nitric acid.

31. Bisulphide of carbon was not decomposed by a current of gaseous terfluoride of boron. Tetrachloride of tin, also bichloride of titanium and cyanogen gas, was found to be freely soluble in carbonic bisulphide. A solution of iodine in the same liquid was decolourised by a stream of hydrogen.

32. By contact of potassium with platinum in a solution of sulphur in bisulphide of carbon, during a long period, the platinum received no carbon deposit; zinc remained bright.

33. Bright metallic thallium rapidly became black in pure carbonic bisulphide which had been re-distilled twice from lead carbonate and porous chloride of calcium. After a period of two years no carbon was separated.

34. Carbon bisulphide instantly precipitated a solution of mercuric chloride in ether.

35. Aluminium became dull, but did not corrode or form crystals, in a solution of phosphorus in carbonic bisulphide, during two years; magnesium behaved similarly.

36. Platinum alone was partly immersed in aqueous solution of argentic nitrate in contact with vapour of carbonic bisulphide. Slow decomposition occurred. In seven weeks the silver was apparently all precipitated as an abundant black powder. No deposit formed upon the platinum wire except just beneath the surface of the liquid.

37. Magnesium, aluminium, or silver, partly immersed in water exposed to vapour of carbonic bisulphide, showed no change in seven weeks, but with silver in contact with platinum, under the same condition, the liquid became dark in colour, and the silver above it blackish, during that time. The same metals, similarly prepared, but with vapour of CCl_4 instead of the sulphide, showed no change during the same period.

38. Magnesium in contact with gold, in water exposed to coal-gas during seven weeks, yielded no deposit except magnesia.

39. Magnesium alone was immersed in amylene; in amylene mixed with some glacial acetic acid in a mixture of absolute alcohol, with acetone, with valerianic acid, with oxalic and acetic acid, with crude vegetable naphtha, with the crude distillate from wood after neutralisation by lime; also in a mixture of glacial acetic acid with sulphuric ether, with benzine, and with toluol, each during several days: no carbon was liberated.

40. An alloy of magnesium and thallium was immersed in liquefied glacial acetic acid, and in a mixture of absolute alcohol and acetic acid; an amalgam of mercury and a little sodium was also immersed in semi-glacial acetic acid; each during several days, without separation of carbon.

41. Magnesium in contact with platinum was immersed in mesitylene (five weeks); in mesitylene and vegetable naphtha (four days); in heavy wine oil (seven weeks); in an aqueous solution of sulphovinate of potassium (nine days); in a solution of naphthaline in vegetable naphtha (four days): it was also immersed (and so also was aluminium), in contact with platinum, in a mixture of absolute alcohol and glacial acetic acid (three days); both in absolute alcohol and with spirit of wine with xylol (two days each); in a solution of dry malic acid in absolute alcohol (two days); and in each case the result was similar to the above.

42. Crystals of silicon and of boron were immersed in a moderately strong solution of carbonate of rubidium at 60° F., in a glass bottle, during two months. No visible chemical effect occurred.

43. Crystals of silicon in contact with platinum dissolved slowly in a mixture of solution of sodic carbonate and hydrate during two years, and left a skeleton of impurity. They also, and aluminium, dissolved slowly in a solution of potassic cyanide; selenium dissolved less slowly, whilst magnesium and boron were unaffected, and white phosphorus became very slowly blackened. White phosphorus, when in contact with platinum, in a solution of potassic carbonate, in a flint-glass bottle, caused the glass to become black on its surface in two years.

44. Numerous experiments were also made of immersing white phosphorus, magnesium, aluminium, silicon, and boron, in contact with platinum, palladium, gold, silver, iron, &c., in solutions of the carbonates and bicarbonates of potassium and sodium, the formiates and oxalates of these metals, during various periods of time, extending in many instances to two years; also in water, glycerin, solutions of sodic hydrate and potassic chloride, exposed to coal-gas, carbonic oxide, carbonic anhydride, carbonic bisulphide, vapour of CCl_4, and in water containing solid chloride of carbon; but in no case was carbon separated.

ACTION OF HYDROCHLORIC ACID ON LEAD.

By S. P. SHARPLES.

Most authors state that lead is but slightly acted upon by hydrochloric acid. In some recent experiments made with a view to destroying cotton fibre by means of the hot acid, it was found that lead-lined vessels were very rapidly destroyed by it, and that even the cold acid could not be kept in wooden tanks lined with lead. These tanks stood sulphuric acid perfectly well.

NOTICES OF BOOKS.

Notes on the Literature of Explosives. By Professor C. E. Munroe, U.S.N.A.

These Notes seem to be the sixth issue of a series. The author first gives a summary of Berthelot's theory of explosions induced by some adjacent explosion. He remarks that formerly the only methods of transmitting an explosion recognised were the direct application of fire or of a violent shock to the substance in question. Now, however, attention has been drawn to explosions by influence, such as are propagated either through the air or through solids which do not participate in the chemical change.

That explosion is so propagated is beyond all doubt. Instances have occurred where detached buildings explode in succession, as in powder-mills, where it may be regarded as certain that no burning materials can have been projected from the first store to the second. In an experiment performed by Captain Müntz a charge of 5 kilos. of dynamite, under water, induced the explosion of another charge of 4 kilos. situate at the distance of three metres. Professor Abel finds that the explosion of a torpedo charged with gun-cotton causes the detonation of other torpedoes within a certain radius.

Berthelot considers that this phenomenon depends on the production of two series of waves; the one representing the explosive waves, properly speaking, developed in the midst of the detonating matter, and consisting of a continuous transformation of chemical action into thermal and mechanical action. The other series is purely mechanical and physical, and transmits the sudden pressure all around the centre of the concussion to the adjoining bodies.

Prof. Abel, on the contrary, brings forward the theory of synchronous vibrations. He holds that the originating cause of the detonation of an explosive substance lies in the synchronism between the vibrations in the first exploding body and those of which the other explosive bodies are capable, just as a violin string vibrates in unison with another vibrating chord. In support of his theory he brings forward the experimental fact that one kind of ex-

plosive cannot by influence determine the detonation of an explosive of a different kind. Thus, nitrogen iodide cannot cause the explosion of compressed gun-cotton. Prof. Munroe, however, seems to lean to the theory of M. Berthelot.

Next follows an account of the so-called "Panclastite" of E. Turpin, formed by mixing liquid nitrogen tetroxide, N_2O_4, with carbon disulphide. It is said to be more powerful than dynamite, not sensitive to blows, whilst the manufacture may be easily controlled by Government, as the tetroxide is not an article of commerce.

What will be of more interest to lovers of piece is that this mixture is capable of other applications. The heat developed is so great that platinum melts instantly, and that even graphite begins to fuse.

Prof. Munroe next quotes from a work by W. N. Hill, now out of print, some particulars on the manufacture of nitro-glycerin. Here we learn that the mixture of nitric and sulphuric acid is now "largely sold," we presume in America. The number of names under which are sold mixtures of nitro-glycerin with other bodies is almost perplexing.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 7, August 18, 1884.

Discourses Pronounced at the Funeral of M. Paul Thenard.—MM. Bouley and Fremy.—M. Bouley referred to the deceased as the fourth eminent French chemist whom the Academy has lost within a comparatively short time, and gave a summary of his researches, especially in agricultural chemistry.

Freezing-point of Saline Solutions.—F. M. Raoult.—The author infers that the molecular lowering of the congelation of salts formed by the monobasic and bibasic acids is the sum of the partial molecular lowering of their electro-positive and electro-negative radicles. Contrary to the author's earlier opinion, the general law of congelation does not apply to salts dissolved in water. The facts, however, tend to show that it is applicable to the constituent radicles of salts, almost as if such radicles were merely mixed in the solutions.

Combinations of Tellurous Acid with Acids.—D. Klein.—To avoid confusion the author calls these compounds salts of tellurium dioxide. He describes the basic nitrate and basic sulphate.

No. 8, August 25, 1884.

Researches on Vegetation: Studies on the Formation of the Nitrates; Methods of Analysis.—MM. Berthelot and G. André.—The presence of nitrates in the vegetable world is, practically speaking, universal, and it is the result of a special function, seated principally in the stem. The authors have found it necessary to analyse separately the roots, the stem, the leaves, flowers, &c., of the plants under examination, separating them from the plant immediately when it was pulled up, and weighing each separately. They determine moisture at 110°, fixed matter, total ash, soluble and insoluble mineral matters, and nitrogen present as ammonia. A portion of the air-dried material was then treated with alcohol at 60 per cent, which dissolves out the nitrates and coagulates the albumenoids. The dissolved portion was evaporated in the water-bath, and the authors determined the weight of the soluble matter (dried at 110°), which they call the hydro-alcoholic extract, and they measured the volume, and consequently ascertained the weight of the nitrogen dioxide yielded by this extract, making use of Schlœsing's process. The portion insoluble in aqueous alcohol was dried, and its nitrogen was determined as ammonia by the soda-lime process. The weight of this nitrogen multiplied by 6 gives, approximately, the weight of the albumenoids, which is less than the weight of the nitrogenised principles contained in the plant, such as the alkaloids in the case of tobacco, and of the Solanaceæ, or the peptones, dissolved by aqueous alcohol. They have found no exact and general method for the determination of these latter principles.

A Thermo-regulator of a Simple Construction, serving also as a Registering Thermometer.—E. H. von Baumhauer.—This instrument cannot be described without the two accompanying figures.

The Ultra-red Emission-Spectra of Metallic Vapours.—H. Becquerel.—The author gives in a table the wave-lengths of the principal emission rays of the incandescent vapours of potassium, sodium, strontium, calcium, magnesium, aluminium, zinc, cadmium, lead, thallium, bismuth, silver, and tin. Nickel gave several very feeble bands or groups of rays; iron, under the conditions of the author's experiments, gave no band sufficiently intense.

Quality of Flours obtained by Different Methods of Grinding.—Aimé Girard.—The author gives his results in the form of tables.

Loss of Nitrogen during the Fermentation of Farmyard Manure.—C. Brame.—The author shows that in papers inserted in the *Comptes Rendus* for 1876 and 1878 he has already replied to the question suggested by M. H. Joulie (*Comptes Rendus*, June 9, 1884), that it is necessary to find means for avoiding their losses. He proposes pits in stables, cow-houses, &c., 1 or 1·5 metre in depth, with cemented sides. In the bottom of these he deposits 0·30 to 0·40 metre of light, very dry earth, above which are placed 0·06 to 0·10 metre of straw, &c. As a convenient "ammonia-scope" he recommends a small stoppered bottle filled with asbestos saturated with glacial acetic acid. Such a bottle, if unstoppered only when examining manure heaps, will remain fit for use for five years. He maintains that farmyard manure can never be superseded by chemical manures and the powdery manures of commerce. These latter, save in certain limited cases, will never become more than adjuncts, and often require substances of the former kind to render them assimilable.

Moniteur Scientifique, Quesneville. Vol. xiv., Sept., 1884.

Discourse delivered at the Third Annual Meeting of the Society of Chemical Industry.—Mr. Walter Weldon.—This discourse, delivered at the Newcastle meeting of the Society of Chemical Industry on July 8, is of course well known to our readers.

A great part of the present issue is taken up with reports of the Proceedings of the Academy of Sciences and with Patent-literature, comprising patents connected with the chemical arts taken in France during the months of June and July last; a selection of French chemical patents issued during June and July; an industrial review of foreign patents, and a special review of patents, chiefly German, connected with the manufacture of artificial colours.

Industrial Society of Mulhouse, June 11, 1884.—M. Schaeffer read a letter from M. de Portheim, calling attention to phenyl-hydrazine, a compound which has much analogy with hydroxylamine. M. Schaeffer has made some attempts to discharge manganese-bronze with this base.

The Secretary read a paper by Dr. Werner on a recent case of poisoning at Thann, under the influence of the benzole used for dissolving caoutchouc. At the Thann

works are used the first portions of the distillation of crude benzol, called light benzol. This substance contains, along with carbon disulphide, ethylic alcohol, carbides of the series of the olefines, amylen, hexylen, &c., benzol, methyl cyanide, or aceto-nitrile, a small quantity of an isocyanide. The experiments undertaken by Werner in conjunction with Noelting prove that the poisonous properties of ordinary benzol are due to a small quantity of this isocyanide. Rabbits poisoned with the benzol of Thann, and others poisoned with ethyl isocyanide, displayed the same pathological phenomena as did the workman who fell a victim, and the benzol from Thann, when freed from this constituent, had no poisonous action.

M. Noelting communicated the sequel of his researches on the xylidins.

MM. Noelting and Weingaertner are engaged with the study of a violet colouring matter formed by the action of sulphuretted hydrogen and ferric chloride upon paramidophenol.

Economical Procedures applicable in the Textile Industry.—Dr. W. Ramsay.—From the *Journal of the Society of Arts.*

Review of Organic Chemistry.—G. de Becchi.—A series of abstracts from the *Berichte der Deutschen Chemischen Gesellschaft.*

Cosmos les Mondes.
No. 12, July 19, 1884.

This issue contains a notice of the death of the Abbé Moigno, who terminated his long career of intense scientific activity on July 13th.

No. 13, July 26, 1884.

Influence of Temperature upon the Characters of the Spectral Rays. — Ch. Fievez. — The author pronounces that the modifications in the appearance of the rays are identical in the spectra of flame and in the electric spectra, whence it may be concluded that an increase of complexity in the constitution of a spectral ray is a certain sign of an increase of the temperature of the emissive ray. Hence it may be inferred that the temperature of the sun-spots is higher than that of the disc, because the spectral rays of the spots have a greater breadth than those of the disc.

The Biological Part of Iron in the Animal Economy.—M. E. Vial.—There exists in the blood-globules a definite compound of potassium and iron, which is originally in the ferrous state in the leucocytes, and is peroxidised in the blood under the influence of the air.

Studies on Potable Waters and Lead.—A. Hamon. —It is proved beyond all doubt that waters which circulate or stand in leaden pipes or vessels, besides the mechanical action due to friction, attack the metal in consequence of the affinity of several of their constituents, the compound produced being generally lead carbonate. Minute quantities of lead introduced into the system must rank among the factors of anæmia and defective nutrition in large towns. Pipes, cisterns, and cooking-utensils of lead ought entirely to disappear.

Presence of Bacteria on Money.—Dr. Heinsch, of Frankfort, has detected upon half-mark pieces which have been long in circulation the presence of bacteria and fungoid growths.

No. 14, August 2, 1884.

A New Proof of the Non-existence of Ammonium Hydrate.—Dr. D. Tommasi.—The author's opinion has been confirmed by the recent researches of M. Bouty on the conductivity of saline solutions. This *savant* has shown that the solution of an anhydrous alkali does not conduct electricity, but that, on the other hand, the solution of a hydrated alkali conducts as do salts. He has also found experimentally that liquid ammonia conducts 110 times more feebly than does a salt of the same molecular weight. This result is quite in harmony with Dr. Tommasi's conclusion that ammonium hydrate is non-existent.

Physical Analysis of Milk. — Dr. C. Brame. — The author declares that his method anticipates by thirty years that of Dr. Georges Quesneville. The points which Dr. Brame determines are the density of the milk, skimmed and unskimmed, the degree of the creamometer, the degree of Downé's lactoscope, the weight of the solid residue at 120°, and, if needful, the absolute quantity of fatty matter. (How if foreign fats have been introduced so as to form a spurious cream ?)

No. 15, August 9, 1884.

This number contains no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c.,
May and June, 1884.

This issue contains no chemical matter.

NOTICE.

The STUDENTS' NUMBER of the CHEMICAL NEWS *will be published on Friday, September 19th. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

Advertisements for this Number should reach the Office not later than Wednesday, the 17th instant.

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LIFE AND WORKS

OF

THOMAS GRAHAM, D.C.L., F.R.S.,

Illustrated by Portrait, 64 Unpublished Letters, and Abstracts of all his Published Papers: prepared for the Graham Lecture Committee of the Glasgow Philosophical Society

BY

Dr. R. ANGUS SMITH, LL.D., F.R.S.

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THE CHEMICAL NEWS.

VOL. L. No. 1295.

A HINT TO STUDENTS.

AN examination of our students' number must convince everyone that the facilities for the study of chemistry have been greatly multiplied. But in addition to the colleges and institutions here particularised there are many classes for the study of the science of which we have not been able to glean any exact information, and which are consequently not mentioned. Further, our literature is exceedingly rich,—richer, indeed, probably than that of any other nation—in chemical hand-books, manuals, "manualettes," and other elementary treatises.

The question then naturally occurs—and we think it deserves the attention of all students—what is the outcome of all these multiplied appliances?

May we not answer, inverting a saying of old, "the labourers are many but the harvest is scanty." As a nation we must confess that in chemistry at least our theoretical discoveries and our practical inventions bear no satisfactory proportion to the number of chemical schools and laboratories or the totality of students who attend them. It may then be seriously asked what is the use of so much teaching and learning if it leads to so little successful investigation into the many unexplored secrets of nature? We are quite unable to say how many out of every hundred students who attend the laboratories which we have enumerated ever try to add even the smallest crumb to the existing sum of human knowledge. We fear that the percentage, could it be ascertained, would not prove a large one. More than the half, probably, when they have acquired a certain knowledge of chemistry, which is officially required as a portion of the qualifications for a degree, or for a profession, dismiss the subject from their minds, and religiously abstain alike from further research and from applying what they have already learnt.

Of such students it is very easy to have too many, and to such it is difficult, if it at all possible or justifiable, to address any words of welcome or of encouragement. But we may legitimately ask why are such barren fig-trees so abundant in our midst? Not, surely, from any defect in our national intellect. Is not the root of the evil to be sought for in the quality of the teaching given. Professor Tilden, in an address reported in the "Mason College Magazine," stated that, as far as chemistry is concerned, "England is now in a fair way to retrieve her fallen fortunes. Abundance of good work is being done. In the matter of instruction we are very little behind the Germans, and we are very rapidly gaining upon them." To the question, "what more do we want?" he replies:—"We want more money for materials and appliances, more students (?), more leisure for the professors, more sympathy from the governing bodies in our work alike of teaching and research, more intelligent recognition of the usefulness of chemical knowledge by our chemical manufacturers." True, we want these things, and something more. Professor Tilden draws a most truthful picture of the state of things in our chemical manufactories. He writes:—"If we go into the iron and steel works of the North of England, into the dye-houses and print-works of Yorkshire and Lancashire, into the alkali-works of St. Helens and the Tyne, we find the laboratories literary swarming with Germans who are holding the situations which ought to be occupied by Englishmen. How long this state of things is to exist is a question which is entirely within the power of young English chemists to determine."

Our fallen fortunes then are as yet not quite retrieved. Nay, it may even be asked whether the number of foreign chemists employed in this country is not increasing, instead of diminishing, a significant comment on the recent revival of technical science among us.

As to what young English chemists can do in the matter we must remember that they and their instructions are alike hampered by the haunting necessity of preparing for examinations. As a matter of course they have less original and suggestive minds than their foreign rivals who have been trained to research.

What more do we want? We want abolition of "payment by results," and of the examinational system altogether. If the higher powers will grant these two points "this state of things" will not exist much longer.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 12th, 1885. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examina-

tions for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1885.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Candidates will be examined as follows:—For a Pass *or* for Honours in (1) Inorganic Chemistry, (2) Experimental Physics, (3) Mathematics; and for a Pass only in (4) General Biology. Candidates may also be examined for Honours in Botany and in Zoology.

Every Candidate, on sending in his name for the Examination, must state whether he intends to compete for Honours in any subject or subjects; and if he does so intend, must specify the subject or subjects.

No Candidate will be allowed to take both the Pass and the Honours Papers in the same subject, but every Candidate must take the Pass Papers in those subjects in which he does not offer himself for Honours.

A Candidate who enters for, but fails to obtain, Honours in Inorganic Chemistry, Experimental Physics, and Mathematics, may be recommended by the Examiners for a Pass in these subjects respectively, if they are satisfied that he has shown such a competent knowledge thereof as is required by the Regulations for the Pass Examination.

The Examiners will make no report upon the Examination for Honours of a Candidate who has failed in any part of his Pass Examination.

Examination for Honours.

Any Candidate who presents himself at the Intermediate Examination in Science for examination in all its subjects may be examined for Honours in (1) Chemistry, (2) Experimental Physics, (3) Mathematics, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Mathematics at the Intermediate Examination in Arts, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in any of the subjects which are common to it with the Intermediate Examination in Science, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the B.Sc. Examination, and has not previously passed the B.A. Examination, may be examined at the Honours Examination next following the B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the Intermediate Examination in Science, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be ex-

amined. The following are the requirements in Chemistry:—

BRANCH IV. OF PHYSICAL SCIENCE.

INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1885.

No Candidate is admitted to this examination until he has passed the Matriculation Examination,* and notice must be given to the Registrar at least 14 days before the commencement of the examination. The fee for this examination is five pounds.

Candidates for the degree of M.B. are required by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and are recommended to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who presents himself at the Preliminary Scientific (M.B.) Examination may be examined for Honours unless he has previously obtained an Exhibition in any one of the subjects at the Intermediate Examination in Science, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

SCHOLARSHIPS.

A Scholarship of the value of Fifty Pounds per annum is biennially offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

A Scholarship of Fifty Pounds per annum, tenable for three years, is also annually awarded to that Candidate in the Honours Division at the June Matriculation Examination who shall stand highest of the Candidates previously approved by the Principal of University College, Bristol; and who intends to study at that College with a view to graduation in one of the Faculties of the University of London. (N.B.—This Scholarship is open to Women.) Further particulars may be obtained on application to the Principal of University College, Bristol.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:

MICHAELMAS TERM, 1885.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 14.

Physical Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 15.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination also admits a Candidate to the Mathematics of the Intermediate Examination in Science, *if taken at the same time*.

Elementary Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

General Principles (advanced,) by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 13.

Elementary Chemistry (especially Metals), by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Elementary Physical Chemistry, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 15.

General Principles (Non-metals) for Natural Science Tripos, by Mr. Heycock, at King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Oct. 15.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 1.30 p.m. Begin Oct. 16.

Practical Chemistry, by the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, and Sidney Colleges. Daily. Begin Oct. 13.

LENT TERM, 1885.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 22.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 23.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 22.

General Principles (continued) by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 23.

Elementary Course (especially Non-metals) by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 22.

Elementary Organic Chemistry, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Jan. 23.

Chemical Philosophy, by Mr. Heycock, King's College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 23.

Chemistry practically applied to Agriculture, by Mr. Robinson, on Mondays, Wednesdays, and Fridays, at 11 a.m. Begin Jan. 23.

Practical Chemistry, at the University Laboratory, and at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 22.

EASTER TERM, 1885.

Elementary Chemistry, by a Demonstrator, on Mondays Wednesdays, and Fridays, at 12 noon. Begin April 24.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10. Begin April 24.

Elementary Course for first M.B. (continued) including Carbon Compounds, by Mr. Pattison Muir, at Caius Laboratory, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin April 23.

Gas Analysis, by the Assistant to the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 24.

Elementary and Advanced Demonstrations in Practical Chemistry, on Mondays, Wednesdays, and Fridays, at 9.15 a.m. Begin April 24.

Practical Chemistry, at the University Laboratory, at St. John's College, at Caius College, and at Sidney College, daily. Begin April 23.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1884-85, are Tuesday, September 30, Wednesday, January 14, and April 15.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the Methods by which Metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The

study of the other subjects above referred to, and also of Assaying, is carried on under the direction of the Professor.

Fees.—Lectures only, £3 3s. Practice (including Lectures), for one month, £6 6s.; two, £11 11s.; three, £15 15s.; six, £27 6s.; nine, £37 16s.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 6th, and will terminate on Friday, March 27th, 1885, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Monday Evenings at 8 p.m., beginning October 6th, 1884.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Professor.—Alex. W. Williamson, Ph.D., LLD., F.R.S.

Lecturers.—Henry Forster Morley, M.A., D.Sc.; R. T. Plimpton, Ph.D.

The Session is divided into three Terms, as follows, all the dates being inclusive :—

First Term, from Friday, October 3rd, until Thursday, December 18th;

Second Term, from Tuesday, January 6th, 1885, till Saturday, March 21st;

Third Term, for Lectures, from Tuesday, April 14th, till Tuesday, June 16th. Class Examinations occupy about ten days, beginning on Wednesday, June 17th.

Students preparing for the Preliminary Scientific Examination who enter in January are recommended to attend the Laboratory, and to supplement the instruction received there with private study of the theoretical part of their work.

Introductory or Matriculation Course.

Third Term: Tuesday, Wednesday, and Friday, at 11. Fee :—£4 4s.

The Course will consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

General Course of Chemistry and Chemical Physics.

First and Second Terms: Inorganic.—The Class meets five times a week: Mondays, Wednesdays, and Fridays, at 11, for Lectures or Examinations; and on Tuesdays and Thursdays, at 9, for Exercises.

Third Term: Elementary Organic.—Lectures or Exercises, Tuesdays, Wednesdays, and Fridays, at 11.

Fee :—For the Course, £7 7s.; Perpetual, £9 9s.; for the First or Second Terms, £3 3s.; for the Third Term, £3 3s.

The subjects treated in the First Terms of the Course include those required in Chemistry at the Matriculation Examination of the University of London.

For the Preliminary Scientific Examination Students attend during the First and Second Terms.

Arrangements will be made to give Candidates for the Preliminary Scientific and Intermediate B.Sc. Examinations, who have attended during the First and Second Terms, opportunities for revising some parts of their work during the Summer Term.

The Third Term provides instruction in the preparation, composition, and fundamental properties of the most common important organic substances. The subjects dealt with include those required by Candidates for the First Examination of the College of Physicians. The last three Meetings will be devoted to recapitulation; and Students who postpone the above examination for a twelvemonth will find it advantageous to attend these meetings in their second year.

Organic Chemistry.

Monday, Wednesday, and Friday, at 9, in the First and Second Terms; and Tuesday and Thursday, at 9, in the Third Term, beginning Wednesday, October 8th. The hour of meeting will be altered should the Class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int.M.B. are, however, recommended to attend this Course during the First and Second Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee :—For the Course, £6 6s.; for a Term, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11 or 10. Each Student will attend twice a week, at the hour allotted to him, on arrangement with the Professor.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary, Scientific, and Intermediate B.Sc. Examinations of the University of London.

Senior Practical Class.

Mondays and Saturdays from 10 to 12 during the Third Term.

Fee :—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Elementary Chemistry. (Women.)

Lectures: Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Second and Third Terms, commencing Wednesday, January 7th.

The common gases and acids will be prepared and examined by the Students themselves.

A few minutes during each Lecture will be devoted to *viva voce* examination on the subject of the preceding Lecture.

One or two questions, to be worked out at home, will be set at each meeting.

Fee :—for the Course, including the cost of apparatus and materials, £4 4s.

Quantitative Analysis.

A Course of Ten Lectures on the newer methods of Qantitative Analysis will be given during the Second Term, on Mondays, at 5. Fee, £1 1s. Some of the more important operations and methods of Quantitative Analysis will be described, including some of the best methods which are of too recent introduction to have found a place in the ordinary text-books.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays, 9 A.M. to 2 P.M., from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week :—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London :—Prel. Sci. (M.B.), Intermediate M.B., Intermediate B.Sc., B.Sc., D.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and T. W. Lovibond, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1884-85, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Chemistry of Brewing.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s.; for the five Courses, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—E. Frankland, Ph.D., D.C.L., F.R.S.
Assistant Professor.—F. R. Japp, M.A., Ph.D.
Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.
Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he select for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs. & Lecs.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.	
	£	£	£	£	£
Chemistry	4	13	15	15	
Physics	5	12	12	12	
Biology with Botany	5	12	12	12	8
Geology with Mineralogy ..	4	8	8		8
Mechanics	4	6	8	8	
Metallurgy	2	13	15		
Assaying for Mining Students		10			
Mining	4	6			
Agriculture	4	10			
Astronomy	2				

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science

schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session by Professors Judd, Chandler Roberts, and Guthrie. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The Session begins on Wednesday, September 17th, 1884.

The College is open to male and female students not under the age of 15 years.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. The Fee for Practical Chemistry, or Practical Physics, is 5s. per Term extra. Any person wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—Sydney Young, B.Sc.

Day Lectures.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 9 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the course.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Special Laboratory Course.

Special instruction will be given on Tuesdays and Thursdays from 3 to 5. The Course is designed for Students entering for elementary examinations in Chemistry, and others to whom the hour may prove convenient.

Fees, £3 3s. for two Terms; £2 2s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Special Lectures will also be given.

Fee, £3 3s.

Advanced Course.

This Course will be given on Saturdays at 9 o'clock during the first and second Terms, and will be devoted to a more minute consideration of Chemical Theory, as shown in recent researches. First Term.—Volume Relation of Solids, Liquids, and Gases; relations between Constitutive and Refractive Index for Light, &c. Second and Third Terms.—Thermal Chemistry.

Fee for the course, £3 3s.; for a single Term, £1 1s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
,, Two Terms ..	13	11	9	7½	5½
,, One Term ..	7	6	5	4	3
,, Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

Correspondence Classes are held for the purpose of giving instruction in chemical processes important to those engaged in the manufacture of woollen goods.

Evening Lectures.

Inorganic Chemistry.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Chemistry of the Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of the Chemistry of the Metals. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

First and Second Terms.—A Course of Lectures will be delivered on Tuesday evenings at 8 o'clock, on the Scouring, Bleaching, and Dyeing of Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee, 15s. for two Terms; 10s. for one Term.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral

bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and ther substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 7, 1884.

Students of the Leeds School of Medicine are admitted to any of the classes on payment of the class fees, and are not charged with the College entrance fee.

Lecture Courses.

1. General Course on Systematic Chemistry —Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £5 5s.

2. Lectures on Laboratory Practice and Chemical Calculation—Monday, at 12.30 during the First and Second Terms. Fee, £1 1s.

3. Chemistry as Applied to Coal Mining—Wednesday, during the First Term, at 4 p.m.

4. Organic Chemistry—Tuesday and Thursday at 12.30 p.m., during the Second and Third Terms. Fee £2 12s. 6d.

5. Lectures on Chemical Technology—Will be varied from session to session. During Session 1884-5 a Course of Twenty Lectures "On the Destructive Distillation of Coal" will be given on Wednesdays, at 4 p.m., during the Second and Third Terms. Fee £2 2s.

6. A Class on Elementary Chemistry, consisting of about Twenty Lessons, on the Non-metals, will be held on Saturdays, at 12.30 p.m., during the First and Second Terms. Fee for the Lecture Class, 10s. 6d.

7. Photographic Manipulation—A Course of Ten Lessons will be given on Saturdays, during the Third Term, from 10 to 1, with special reference to dry plate processes and silver and platinum printing. Fee, £1 1s.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session.—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, n Wednesdays, at 7.30 p.m., beginning October 15. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years. Fee, £3 3s.

Several valuable Scholarships are at the disposal of the College, viz., the Cavendish, Salt, Akroyd, Brown, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., B.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Friday, October 3rd, 1884.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12.30. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommmended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 10 a.m., commencing Wednesday, October 8th, 1884. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 9.30 a.m. Fee, £2 2s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practica

Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees :—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Threee Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—Two Courses of about Ten Lectures each will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2.30, on the Principles and Practice of Metallurgy. Fee for each Course, 10s. 6d.

Arrangements will be made in the Chemical Laboratory or giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

Assistant.—H. Ll. Snape.

The Session commences October 1st. The Chemical Laborarories have been enlarged so as to accommodate 70 Lecture Students and 48 Working Students; the contemplated further large extensions have already been commenced.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum :—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two or three days a week, during the Lent and Summer Terms; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry — Second Attendance on General Lecture Course, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Lectures on Organic Chemistry. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable manner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Laboratory is opened for Students from 10 a.m. to to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5. Fee for a course of two years' instruction in General and Applied Chemistry, Sixty Guineas. Evening Courses are held during the Winter Session on Chemistry, Metallurgy, and Physics. A course of lectures specially adapted for those engaged in Engineering and Iron and Steel Works will be held on Tuesdays. Prospectuses containing full particulars of the laboratory and lecture courses may be had on application at the College.

UNIVERSITY OF DURHAM. COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—Saville Shaw.

The Session will commence on September 29th, 1884.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Mondays, Wednesdays, and Fridays, at 12.5 p.m. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry. Tuesdays and Thursdays, at 11. Fee, £5 5s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes :—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations :—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises :—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises :—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next

to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 22nd of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, September 29th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

VICTORIA UNIVERSITY.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, LL.D., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Arthur Smithells, B.Sc., and W. Bott, Ph.D.

The Session begins on October 7, 1884, and ends on June 26, 1885.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior. Preparatory:—Chemical Laboratory, two days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Physiography). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior* and Senior, classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third and fourth courses). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 1s. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees for every combination of classes. Special prospectuses may be obtained at the office of the College.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

The following are some of the more important Exhibitions, &c., available to students:—

Entrance Exhibitions.

Wellington Exhibition (Greek Testament), £15.

Dalton Mathematical Exhibition, £15. Renewable for a second year.

Grammar School Scholarship, £18 10s. per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

Gilchrist Scholarships, three of £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London.

Rumney Scholarship, £45 per annum, tenable for three years.

Ramsbottom Scholarship, £40 per annum, tenable for two years.

Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1886. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Dauntesey Medical Scholarship, £100.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

Victoria Scholarship (Classics), £40 per annum, tenable for two years.

Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

Dalton Chemical Scholarships, £50 per annum, tenable for two years.

Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years.

Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

Shuttleworth History Prize, value £5.

English Essay and Poem Prizes, each of the value of £5.

Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

New Shakspere Society's Book Prizes.

Cobden Club Book Prizes (Political Economy).

Dalton Natural History Prize, value £15.

Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecture Courses.—A systematic course of day lectures is delivered on Tuesday and Thursday afternoons at 4.30: the non-metals are treated of in the Autumn Term (October 6th to December 20th), the metals in the Spring Term (January 19th to April 4th), and the carbon compounds in the Summer Term (April 27th to July 13th).

A course of evening lectures runs parallel with the day course, being delivered on Wednesday evenings at 8 o'clock.

A lecture class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Excursions are conducted by the Professor to works where the technical applications of chemistry may be seen by the students.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For the day lectures, £2 10s. for the session, and one guinea for a term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in Chemical Analysis, and in Experimental and Applied Chemistry. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible; no extra charge is made for the use of gas and water, and of the cheaper chemicals.

Fees.—Inclusive fee £15 per session, or £6 6s. per term; terminal fee for day students for three hours weekly 20s., for six hours 35s., for nine hours 50s., and 10s. extra for each additional three hours per week; for evening students 10s. for one evening per week, and 20s. for two evenings per week.

Government Classes.—Under the direction of the Demonstrator.

Lecture Courses.—Inorganic Chemistry, Monday evening; Organic Chemistry, Friday evening. Fee, 2s. 6d. for the Session.

Practical Chemistry.—On Tuesday and Thursday evenings from 7 to 9. Fees, one evening per week, 5s.; two evenings per week, 10s., for session.

All classes of Students are eligible to attend without distinction of sex. In virtue of the affiliation of the University College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge. For other information Students are referred to the College Calendar.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Tuesday, October 7, 1884.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 2s.

Third Year's Course.—Organic Chemistry, on Tuesday, Thursday, and Saturday, from 10 to 11. Fee, £1 11s. 6d. Chemical Philosophy, on Saturday at 10. Fee, £1 1s.

Analytical Chemistry.—Lecture course by Mr. O'Shea. Friday, 11 to 12. Sessional fee, £1 11s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £4 10s.; Nine, £6 10s.; Twelve, £8; Eighteen, £11 4s.: Twenty-four, £14; Thirty, £16 16s.; Thirty-six, £19.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-six hours per week):—For one month, £3 13s. 6d.; two months, £6 6s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for two days a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Tuesday and Friday, 7 to 8. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, three hours per week, £2 5s.; six, £4 8s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—John Foggie.

The second session of the College will be opened on October 8th, 1884.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians, London, and for degrees in Science and Medicine by the University of Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more impor-

tant compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 1 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 28, 1884.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistants.—James B. M'Arthur and Robert Anderson.

Junior Assistants.—Archibald Kling and Alex. Lamb.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10.15 to 11.15, commencing on Wednesday, Oct. 29th. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, select chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 1.

The Laboratory is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the courses of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but Mr. Dittmar makes it a strict rule not to use his students as his private assistants in connection with his own investigations, and to rather discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Of the several duties which the prestige and traditions of this Chair impose upon its occupant, the first and foremost is to offer to young men, of even limited means, the opportunity of receiving a training in chemistry sufficient to prepare them fully for positions in chemical works, or as professional chemists.

A special Practical Class for Medical Students, meeting twice a week for two hours each time, is conducted during the Summer Session. Fee, including all expenses, £2 2s.

The Evening Department opens on the 3rd of October.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Assistant.—Mr. C. Ellis.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 3rd. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. The earlier Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Evening Courses.—There will be special Evening course of twenty-five lectures on Oils, Paints, and Varnishes. Other Courses of Lectures and Practical Courses will be arranged.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S E., F.C.S.

The Session begins October 21st.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and on the same days at 3 p.m., after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 21st. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

UNIVERSITY OF DUBLIN.

Trinity College.

Professor of Chemistry.—J. Emerson Reynolds, M.D., F.R.S.

Senior Assistant and Demonstrator.—William Early, F.I.C.

The professor of chemistry lectures on Elementary Chemistry during the whole of Michaelmas and Hilary Terms, on the Non-Metals and Metals; and the students repeat in the Laboratories many of the experiments shown at lecture.

The advanced course consists chiefly of Laboratory instruction in qualitative analysis (including spectrum analysis) commencing in Michaelmas Term, about November 1st. Volumetric and gravimetric analysis, commencing in Hilary Term. Organic preparations and analysis, commencing in Trinity Term.

Professor Reynolds lectures on Organic Chemistry during Trinity Term. In the main Laboratory facilities are afforded for the prosecution of experimental researches.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,

Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 6, 1884.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education, Technical College, Finsbury.—Professor, H. E. Armstrong, Ph.D., F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a

comparatively early age; of a supplementary school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superintendent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Monday, October 6th, and ends on December 19th; the Spring term commences on the second Monday in January, and ends about the 21st of March; the Summer term commences about the 15th of April and ends about July 16th, the evening classes terminating in June. An examination for the admission of Students will be held at the College at 10 o'clock on Thursday, October 2nd, 1884, and the work of the Session will commence on Monday, October 6th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

CITY OF LONDON COLLEGE.—Professor, Dr. A. B. Griffiths, F.C.S., &c. A course of about 35 Lectures on Metallurgy, Metallurgical Chemistry, and Assaying, will be delivered every Friday evening from 7 to 8, commencing on October 3rd. The lectures will comprise the following subjects:—Processes used in the Extraction (by dry and wet methods) of all the important Metals. Materials used in the construction of Furnaces, Crucibles, Retorts, &c. Fuel, Calorific Power, Coking and Coking Ovens. Assaying of Metals and Alloys. Machinery and appliances used in Metallurgical operations. Composition of Slags. Hot and Cold Blast, &c. This course will meet the requirements of those students competing for Whitworth Scholarships, Science Department and other examinations. It is a course most useful for students desirous of following the Chemical Profession. Prospectuses and further details on application to the Secretary of the College. White Street, Moorfields, E.C., or to Dr. Griffiths, The Heath, Bromsgrove.

BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION, BREAM'S BUILDINGS, CHANCERY LANE.—*Organic Chemistry:* A course of 30 Lectures, beginning on October 7th, at 7 p.m., by Mr. H. Chapman Jones. Also a class for Practical Work, conducted by Mr. Chapman Jones, will meet in the Laboratory of the Institution at 8 p.m. on October 7th. *Photography:* A course of 30 Lectures, with Demonstrations on the Theory and Practice of Photography, by Mr. H. Chapman Jones, beginning at 7 p.m., on October 1st. *Inorganic Chemistry:* A course of 30 lectures to Elementary Students, beginning on October 7th, and a similar course to Advanced Students, beginning on October 12th, by Mr. George Chaloner. Classes for Practical Chemistry and Analysis on Tuesday and Saturday evenings, beginning on October 7th, conducted by Mr. George Chaloner.

CRYSTAL PALACE COMPANY'S SCHOOL OF ART, SCIENCE, AND LITERATURE. SCHOOL OF PRACTICAL ENGINEERING. *Principal*—Mr. J. W. Wilson, Memb. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session.				Summer Session.			
	Lecturers on Chemistry.	Days and Hours.	Fees.		Lecturers on Chemistry.	Days and Hours.	Fees.	
			One Course.	Perpetual.			One Course.	Perpetual.
			£ s.	£ s.			£ s.	£ s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6 16/6	9 9	Dr. Russell	M. Tu. F., [to 1 11	3 3	3 3
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 4	5 5		Mr. Heaton		4 4	
St. George's Hospital ..	Mr. Donkin	Tu. Th. S., 11½	6 6	7 17/6	Mr. Donkin	Daily at 10	4 4	
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7		Mr. Groves	M. W. F., 10 to 1	7 7	
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10¼	8 8	11 11	Mr. Bloxam and Mr. Thomson & Mr. Johnson	M. W. Th., 10¼	6 6	8 8
London Hospital	Dr. Tidy	M. W. F., 10.30	7 7	10 10	Dr. Tidy	M. W. S.	5 5	
St. Mary's Hospital ..	Dr. Wright	M. Th. 10, W. S., 9	6 16/6		Dr. Wright	W. F. S., 9	4 4	
Middlesex Hospital ..	Mr. W. Foster	M W.Th. Fr., 3	8 8		Mr. W. Foster	M. W. F., 3	4 4	
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th. F., 10½	7 7	10 10	Dr. Bernays	M. Th. F., 10	6 6	
University Col. & Hosp.	Dr. Williamson, F.R.S.,	Daily (ex. S.), 11	7 7	9 9	Dr. Williamson	Dy. (ex. M. S.) 11	5 5	
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	6 6	8 8	Dr. A. Dupré	M. W. F., 10	4 4	

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, Literature, &c., so that education of the highest class might be afforded under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Ex-

amination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1883-84:—Cambridge Local, December, 1884; Oxford Local and Oxford Examination for Women, June, 1885; Cambridge Higher Examination, June, 1885. The session opens on October 1.

DENTAL HOSPITAL, London.—Prof. A. K. Huntington. Course of Lectures on Metallurgy in its Application to Dental Purposes.

NEW CENTRAL SCHOOL OF CHEMISTRY AND PHARMACY, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

SOUTH LONDON SCHOOL OF CHEMISTRY, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

ST. JOHN'S TRAINING COLLEGE, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College. Lecturer and Director of the Laboratory, Alfred Senier, M.D., F.I.C., F.C.S.

THE WESTMINSTER COLLEGE OF CHEMISTRY AND PHARMACY, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 9 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, 17, Bloomsbury Square.—The school opens on Wednesday, the 1st of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, assisted by Mr. Wyndham R. Dunstan, F.C.S., on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, and Mr. Eastes, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s; for Practical Chemistry, 10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes.*—At the end of each of the five months Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session.

ONSLOW COLLEGE OF SCIENCE, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

BIRMINGHAM.—QUEEN'S COLLEGE.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

BRISTOL MEDICAL SCHOOL.—Mr. T. Coomber, F.C.S.

DERBY CENTRAL SCHOOL OF SCIENCE.—Evening Lectures and Practical Laboratory Instruction, commencing September 29. Physics and Mathematics—H. Barfield, D.Sc. Chemistry—L. Archbutt, F.C.S.

INSTITUTE OF CHEMICAL TECHNOLOGY, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus. Fee: Fifty guineas per annum, with extra fee according to circumstances for the special course.

LEEDS SCHOOL OF MEDICINE.—Prof. T. E. Thorpe, Ph.D., F.R.S.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Dr. H. Wilson Hake, F.C.S., F.I.C. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction.

SALFORD WORKING MEN'S COLLEGE, EVENING CLASSES.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

UNIVERSITY OF ABERDEEN.—Mr. J. S. Brazier, F.C.S.

SCHOOL OF MEDICINE, SURGEON'S HALL, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, and Mr. Drinkwater.

EDINBURGH SCHOOL OF PHARMACY AND CHEMISTRY.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Dr. Stewart gives instruction to Pharmaceutical Students in the B. P. tests. Day and Evening Classes.

EDINBURGH SCHOOL OF MEDICINE, 41, Chambers St.—Dr. Drinkwater, F.C.S.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

NEW VETERINARY COLLEGE, LEITH WALK, EDINBURGH.—Dr. Stevenson Macadam.

SCIENCE SCHOOLS, FALKIRK.—Mr. Andrew Wilson and Assistants. Day and Evening Classes in Theoretical and Practical Chemistry and Metallurgy.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke.

COLLEGE OF SCIENCE AND ARTS, GLASGOW.—Mr. A. Humboldt Sexton. Day and Evening Classes.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Dr. C. A. Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

DUBLIN, CARMICHAEL COLLEGE OF MEDICINE.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Dr. Campbell.

DUBLIN, DR. STEEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

MECHANICS' INSTITUTE, Abbey Street, Dublin.—Mr. Clement J. Leaper.

Electrolysis Applied to the Analysis of Red Wine.—L. Monrad Krohn.—The electrolysis of a red wine, joined to the microscepic examination of the deposit formed is, according to the author, a certain means of detecting if the colouration of the sample is natural.—*Journ. de Phar. et de Chimie.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Cosmos les Mondes.
No. 16, August 16, 1884.

What is to be done during Epidemics of Cholera?—Thomasi Crudeli.—The author pronounces it practically impossible to guard against the invasions of epidemics by cordons, quarantines, and fumigations, and recommends sanitary reform. He proposes that the clothing of the sick should be disinfected by steeping in water containing 0·2 per cent of mercuric chloride,—a precaution which he found satisfactory at Palermo during the epidemic of 1866.

No. 17, August 23, 1884.

Petroleum Industry in the Caucasus.—Translated from *Engineering*.

Determination of Nitric Acid as Cinchonamine Nitrate.—M. Arnaud.—Already inserted.

Journal de Pharmacie et de Chemie.
Series 5, Vol. ix., March, 1884.

Researches on the Alkaline Sulphites.—M. Berthelot.

Pyrogenous Decomposition of Potassium Sulphite.—M. Berthelot.

On the Metasulphites.—M. Berthelot.

Examination and Analysis of Two Samples of Wine from Cochin China.—M. Sambuc.—These wines are obtained from the fruit of a tuberous-rooted vine, the stem of which dies down annually in November and shoots out again in March. The acidity of the wines is high, and the proportion of alcohol low.

The Danger of the Use of Badly Vulcanised Caoutchouc Tubes in Certain Chemical Operations.—M. Limousin.—The presence of sulphur and of antimony sulphide is especially dangerous in the preparation of oxygen gas.

On Meat-Powders.—M. Yvon.—This paper does not admit of useful abstraction.

OWENS COLLEGE (VICTORIA UNIVERSITY), MANCHESTER.

SESSION 1884-5.

I. DEPARTMENT of ARTS and LAW.
II. DEPARTMENT of SCIENCE and ENGINEERING.
Candidates for Admission in these Departments must not be under 14 years of age, and those under 16 will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on the 3rd OCTOBER.
III. DEPARTMENT of MEDICINE and SURGERY and of DENTAL SURGERY.
Students are required, before entering, to have passed either the Entrance Examination in Arts, or the Preliminary Examination in the Victoria University, or some other of the Preliminary Examinations prescribed by the General Medical Council.
IV. DEPARTMENT for WOMEN (223, Brunswick-street).
The SESSION in Departments I., II., and IV., will commence on the 7th, and in III., on the 1st OCTOBER.
V. EVENING CLASSES.
The SESSION will commence on the 13th OCTOBER. New Students will be admitted on the 8th, 9th, and 10th October, between 6.30 and 9 p.m.
ENTRANCE EXHIBITIONS and SCHOLARSHIPS are offered to be Competed for by Male Students in Classics, Greek, Testament, Mathematics, English, and History; and also a DAUNTESEY MEDICAL SCHOLARSHIP, value £100. FOUR SCHOLARSHIPS of the value of £20 per annum, tenable for three years, in the Department for Women, have also been founded, of which two are open to general competition, and two may be competed for only by Pupils in the Manchester High School for Girls.
Prospectuses of the several Departments may be obtained at Mr. CORNISH'S, Piccadilly, Manchester, and they will be forwarded from the College on application.

J. HOLME NICHOLSON, Registrar.

CARBONATE OF AMMONIA from Ammoniacal Liquor,—Dr. Siedler's Patent process. For Royalty and particulars apply to J. Berger Spence and Co., Manchester.

THE MASON COLLEGE, BIRMINGHAM.
SESSION 1884-85.

FACULTIES OF SCIENCE AND ARTS.

The SESSION will commence on FRIDAY, the 3rd of OCTOBER NEXT.
All departments of the College are open to both sexes on the same terms. Special arrangements are made for the convenience of ladies.
Syllabuses containing full information as to Admission of Students, Courses of Instruction, Fees, Entrance and other Scholarships, &c., will be forwarded on application to

GEO. H. MORLEY, Secretary.

UNIVERSITY COLLEGE, LIVERPOOL.

The SESSION will commence on Wednesday, October 1st. EVENING CLASSES on October 6th.
Full Courses of Lectures for all London University Examinations in Arts or Science. Physical, Chemical, and Biological Laboratories.
All Classes (except the Medical) open to both sexes on the same terms.
For full details of Classes, Fees, &c., see "Calendar" (price 2s.), published by ADAM HOLDEN, 48, Church Street, Liverpool.

INSTITUTE OF CHEMICAL TECHNOLOGY
AND
ANALYTICAL LABORATORY,
5, 9, and 11, PHILADELPHIA CHAMBERS, HACKINS HEY, and 3 and 12 A, ASHTON CHAMBERS, HACKINS HEY, LIVERPOOL.

PRINCIPAL—A. NORMAN TATE, F.I.C.

Designed for the examination, for scientific, commercial, and industrial purposes, of substances used and produced in the Arts and Manufactures, and found in Commerce; and for the instruction of Students in Chemistry and the allied sciences in their relation to industrial and commercial pursuits.
The Laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and Students' work.
Students' fees, fifty guineas per annum.
In addition to their chemical studies, Students who desire it can enter upon a course of instruction calculated to afford them knowledge useful in the erection and arrangement of manufacturing buildings and plant, and construction of apparatus. Special fees are charged for this course.
All communications should be addressed to Mr. A. Norman Tate, 9, Hackins Hey, Liverpool, as, owing to similarity of surname with that of the principal of another chemical establishment in Liverpool, misconception and mistakes have arisen.

LIVERPOOL COLLEGE of CHEMISTRY,
DUKE STREET, LIVERPOOL.
Founded by Dr. SHERIDAN MUSPRATT.

PRINCIPAL—Dr. GEORGE TATE, F.C.S., F.G.S.

The design of the College is to give a thorough knowledge of Chemistry in all its relations and applications to Medicine, Agriculture, and the Chemical Arts generally.
Every accommodation is afforded in the Laboratories of the College for original research and analytical investigation.
Fee for the two years' course of study, 60 guineas.
Prospectuses of the Day and Evening Classes, commencing in October, may be had on application.

THE YORKSHIRE COLLEGE, LEEDS.

The Eleventh Session of the Department of Science, Technology, and Arts will begin, in the new buildings, College Road, Leeds, on the 7th October. The Classes prepare for the examinations of the University of London, Scholarships at Oxford and Cambridge, and for various professions. They include Mathematics, Physics, Chemistry, Geology, Biology, Latin, Greek, English, French, German, and Oriental Languages and Literatures, History, Metal and Coal Mining; Civil, Mechanical, and Electrical Engineering; Weaving, Designing and Dyeing Textile Fabrics, &c.
The Fifty-fourth Session of the Medical Department (formerly the Leeds School of Medicine) begins October 1st.
The Chemistry Classes and Chemical Laboratories, under Dr. THORPE, F.R.S., offer courses of systematic lectures in Organic and Inorganic Chemistry, Chemical Calculations, Chemistry as applied to Coal Mining, Chemical Technology, Chemical Physics, and Photographic Manipulation: and practical work for periods to suit the other engagements of Students.
The Dyeing Classes and Dye-house, under Instructor HUMMEL, F.C.S., late of the Polytechnikum, Zürich, provide lectures on Textile Fibres, Natural and Artificial Colouring-matters, Mordants, and other subjects included in a complete course of dyeing instruction; and practical dyeing and printing of textile fabrics, &c.
Prospectuses may be obtained from the Secretary.

THE CHEMICAL NEWS.

Vol. L. No. 1296.

ADDRESS TO THE MECHANICAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.

By Sir F. J. BRAMWELL, F.R.S., V.P.Inst.C.E., President of the Section.

In a family of seven children there are two who are of paramount importance:—the eldest, at the one end of the scale, important, because he is the heir, the firstborn; and at the other end of the scale, the little Benjamin, important because he is the last, the youngest, and the dearest. The position of little Benjamin is not, perhaps, quite as honourable as that of the heir, and not, when the family breaks up, by any means as good; but while the family holds together, Benjamin receives an amount of attention and consideration that does not fall to the lot of any one of the intermediates, not even to the heir himself. But there is one risk about Benjamin's position, a risk that cannot appertain to the post of the first-born; little Benjamin may be deposed by the advent of a lesser Benjamin than himself, whereas the first-born becomes (if possible) still more the first-born for each addition to the family. Perhaps some of you may say, Be it so; but what has this to do with the address of the President of Section G? Those who make this inquiry, however, certainly have not present to their minds the change that has this year taken place. Up to and including the Southport meeting, Section G was the little Benjamin among the seven sons of the B.A. (I will not waste your time by giving the name of the Association in full, nor will I affront you by using an abbreviation which is occasionally improperly applied), but at Montreal appears Section H, and G becomes relegated among those uninteresting members of the family who are neither the important head nor the cherished tail. I grieve for Benjamin, and I think the present occasion an apt one for magnifying Section G. Apt for two reasons: the foregoing one, that H has deposed it from its position; the other, that we are meeting in Montreal—and in reference to this latter reason, let me ask, Is it not the fact that to the labours of the men who have been, or are (or ought to be) members of Section G is due the possibility of the meeting taking place on this side of the Atlantic?

At our Jubilee meeting at York, I called the attention of the Section to the fact that in 1831, when the Association first met in that city, they arrived there laboriously by the stage-coach, and that practically the Manchester and Liverpool, the Stockton and Darlington, and some few others, were the only railways then in existence. I also called their attention to the fact that in 1831 there were but very few steamers. I find the total number registered in the United Kingdom in that year was only 447. If under this condition of things, the proposition had been made in 1832 at Oxford, as it was made in 1882 at Southampton, that the next meeting but one of the Association should take place in Montreal, the extreme probability is that the proposer would have been safely lodged in a lunatic asylum, for suggesting that that which might have involved a six-weeks' voyage out, and a four weeks voyage back, could ever be seriously entertained. Further, to give once more the hackneyed quotation, some few years after this, *i.e.* in 1836, Dr. Lardner established to his own satisfaction conclusively, that no vessel could ever steam across the Atlantic the whole way. A striking instance of the mistakes made by scientific speculation; a branch of science widely differing in the value of its results from those branches which deal with absolute demonstration. Undeterred, however, by such adverse opinion, the engineers "kept on pegging away," experimenting, improving, and progressing, until the scientific speculation was met with the hard fact of the Atlantic voyage steamed the whole way by the "Sirius" and by the "Great Western" in 1838. The impossible was proved to be the possible, and from that day to this the advancement of steam ocean navigation has continued. The six-weeks' voyage, sailing westward of the year 1831, has become converted into but little over six days. And thus it is that that which would have been a mad proposition in the year 1832, became a perfectly rational one in 1882; and the deliberations of the General Committee on the proposition were not directed as to whether it would be possible to convey the members with certainty, expedition, and economy across the Atlantic, but as to whether it was expedient or not on general grounds to hold for the first time a meeting of the British Association elsewhere than in some city of the United Kingdom. I say again that the possibility of such a meeting is absolutely due to the engineer, and that therefore, on this ground, the present is an appropriate occasion to magnify G, the Mechanical Section of this Association.

It is true that the man who looks only at that which is on the surface may say, "You arrogate too much to yourselves. You ignore (to which I say Heaven forbid!) the skill and daring of your sailors. You ignore commercial enterprise. You ignore the development of iron and steel manufacture, which have enabled you to build the steamers of the present day. You ignore the increased output of the best steam coal in the world, and the attribute the whole result to the engineer" Such an objector would be in the condition of that man who, in answer to George Stephenson's question, "What is causing that railway train to move?" said, "Why, I suppose the coal that is burning in the locomotive;" and who was met by that grand and comprehensive answer, that it was the "Sun," for the coals were a consequence, and not a first cause. Similarly I venture to say that the mechanical engineer may lay claim to be the central source which has vivified and given rise to the improvements in the manufacture of iron and steel, in the construction of engines, and in the development of our collieries.

There are those I know who object that Section G deals too little with pure science, too much with its applications. It may be as the members of Section G might retort, that it is possible to attend so much to pure science as to get into the unchecked region of scientific speculation, and that had the members of Section G been debarred from the application of science, the speculation of Dr. Lardner might to the present day have been accepted as fact.

I have quoted it before, but it has so important a bearing on this point, and comes from a man of such high authority, that I cannot refrain from once more giving you Dr. Tyndall's views on this question.

"The knowledge of nature, and the progressive mastery over the powers of nature, imply the interaction of two things—namely, thought conceived and thought executed; the conceptions of the brain, and the realisation of those conceptions by the hand. The history of the human intellect hardly furnishes a more striking illustration of this interaction of thought and fact than that furnished by the Association of Physics and Engineering. Take for instance the case of steam. Without knowing its properties, the thought of applying steam could not have arisen; hence the first step was physical examination. But that examination suggested practice, and the steam-engine at last saw the light; thus experimental physics was the seedling from which the steam-engine sprang. But the matter did not end here: the positions of debtor and creditor were soon reversed, for the stupendous operations of the steam-engine forced men of thoughtful philosophic minds to inquire into the origin of the power of steam. Guess succeeded guess, inspiration succeeded inspiration; the ever present fact of our railways, and our power-looms, and our steamships gave the mind no rest until it had answered the question, How are heat and

steam, its instruments, related to mechanical power? Had the works of the engineer not preceded the work of the natural philosopher, this question would never have been asked with the emphasis, nor pursued with the vigour, nor answered with the success, which have attended it. It was the intellectual activity excited by the work which the civil engineers of England had accomplished that gave to philosophy the theory of the conservation of energy including the dynamical theory of heat. . . . The engineering genius of the future is certain to derive from this theory strength and guidance. Thus necessarily has thought originated fact, and fact originated thought. In the development of science these two powers are coequal; each in turn ceasing to be a consequence, and becoming a creative cause. The Atlantic cable also had its small beginnings in the laboratory of the physical inquirer. Here, as before, experimental physics led the way to engineering facts of astounding magnitude and skill. But here also the positions of debtor and creditor have been reversed, for the work of the engineer has caused the physical inquirer to pursue his investigations with a thoroughness and vigour, and has given to those investigations a scope and magnitude which, without the practical stimulus, would have been impossible. The consequence is that the practical realisation of sending electric messages along the bottom of the Atlantic has been an immense augmentation of our knowledge regarding electricity itself. Thus does the human intelligence oscillate between sound theory and sound practice, gaining by every contact with each an accession of strength. These two things are the soul and body of science. Sever sound theory from sound practice, and both die of atrophy. The one becomes a ghost and the other becomes a corpse."

I think all men, even although they be followers of science in its purest and most abstract form, must agree that these words are words of sound sense, well worthy of being borne in mind and of being acted on, and will, therefore, concur in the propriety of Section G dealing with engineering subjects generally as well as with abstract mechanical science. Once admitting this, I may ask—certain what the answer must be—whether there is any body of men who more appreciate and make greater use of the applications of pure science than do the members of this Section. Surely every one must agree that we engineers are those who make the greatest practical use not only of the Science of Mechanics but of the researches and discoveries of the members of the other sections of this Association.

Section A, *Mathematical and Physical Science.* The connection between this Section and Section G is most intimate. With any ordinary man I should have referred, in proof of this intimate connection, to the fact that the President of A this year is a member of the Council of the Institution of Civil Engineers, but when I remind you that it is Sir William Thomson who fills this double office, you will see that no deduction such as I have hinted at can be drawn from his dual functions, because the remarkable extent and versatility of his attainments qualify him for so many offices, that the mere fact of his holding some one double position is no certain evidence of the intimate connection between the two. But setting aside this fact of the occupancy of the chair of A by a civil engineer, let us remember that the accomplished engineer of the present day must be one well grounded in thermal science, in electrical science, and for some branches of the profession in the sciences relating to the production of light, in optical science and in acoustics; while, in other branches, meteorological science, photometrical science, and tidal laws are all important. Without a knowledge of thermal laws, the engineer engaged in the construction of heat motors, whether they be the steam-engine, the gas engine, or the hot-air engine, or engines depending upon the expansion and contraction under changes of temperature of fluids or of solids, will find himself groping in the dark; he will not even understand the value of his own experiments, and therefore will be unable to deduce laws from them; and if he make any progress at all, it will not guide him with certainty to further development, and it may be that he will waste time and money in the endeavour to obtain results which a knowledge of thermal science would have shown him were impossible. Furnished, however, with this knowledge, the engineer starting with the mechanical equivalent of heat, knowing the utmost that is to be attained, and starting with the knowledge of the calorific effect of different fuels, is enabled to compare the results that he obtains with the maximum, and to ascertain how far the one falls short of the other; he sees even at the present day that the difference is deplorably large, but he further sees in the case of the steam engine, that which the pure scientist would not so readily appreciate, and that is, how a great part of this loss is due to the inability of materials to resist temperature and pressure beyond certain comparatively low limits; and he thus perceives that unless some hitherto wholly unsuspected, and apparently impossible, improvement in these respects should be made, practically speaking the maximum of useful effect must be far below that which pure science would say was possible. Nevertheless, he knows that within the practical limits great improvements can be made, he can draw up a debtor and creditor account, as Dr. Russell and myself have done, and as has been done by Mr. William Anderson, the engineer, in the admirable lecture he gave at the Institution of Civil Engineers in December last on The Generation of Steam and the Thermo-dynamic principles involved. Furnished with such an account, the engineer is able to say, in the language of commerce, I am debtor to the fuel for so many heat units, how, on the credit side of my account, do I discharge that debt? Usefully I have done so much work, converted that much heat into energy. Uselessly I have raised the air needed for combustion from the temperature of the atmosphere to that of the gases escaping by the chimney; and he sets himself to consider whether some portion of the heat cannot be abstracted from these gases and be transmitted to the incoming air. As was first pointed out by Mr. Anderson, he will have to say a portion of the heat has been converted into energy in displacing the atmosphere, and that, so far as the gaseous products of the coal are concerned, must, I fear, be put up with. He will say, I have allowed more air than was needed for combustion to pass through the fuel, and I did it to prevent another source of loss—the waste which occurs when the combustion is imperfect; and he will begin to direct his attention to the use of gaseous or of liquid fuel, or of solid fuel reduced to fine dust, as by Crampton's process, as in these conditions the supply may be made continuous and uniform, and the introduction of air may be easily regulated with the greatest nicety. He will say, I am obliged to put among my credits—loss of heat by convection and radiation, loss by carrying particles of water over with the steam, loss by condensation within the cylinder, loss by strangulation in valves and passages, loss by excessive friction or by leakage; and he will as steadily apply himself to the extinction or the diminution of all such causes of loss, as a prudent Chancellor of the Exchequer would watch and cut down every unproductive and unnecessary expenditure. It is due to the guidance of such considerations as these that the scientific engineer has been enabled to bring down the consumption of fuel in the steam-engine, even in marine engines such as those which propelled the ship that brought us here, to less than one-half of that which it was but a few years back. It is true that the daily consumption may not have been reduced, that it may be even greater, but if so it arises from this, that the travelling public will have high speed, and at present the engineer, in his capacity of naval architect, has not seen how—notwithstanding the great improvements that have been made in the forms of vessels—to obtain high speed without a large expenditure of power. I anticipate from the application of thermal science to practical engineering, that great results are before us in these heat motors, such

as the gas-engine, where the heat is developed in the engine itself. Passing away from heat motors, and considering heat as applied to metallurgy: From the time of the hot blast to the regenerative furnace, it is due to the application of Science by the engineer that the economy of the hot blast was originated and that it has been developed by the labours of Lowthian Bell, Cowper, and Cochrane. Equally due to this application are the results obtained in the regenerative furnace, in the dust furnace of Crampton, and in the employment of liquid fuel, and also in operations connected with the rarer metals, the oxygen furnace and the atmospheric gas furnace, and, in its incipient stage, the electrical furnace. To a right knowledge of the laws of heat and to their application by the engineer must be attributed the success that has attended the air-refrigerating machines, by the aid of which fresh meat is at the end of a long voyage delivered in a perfect condition; and to this application we owe the economic distillation of sea water by repeated ebullitions and condensations at successively decreasing temperatures, thus converting the brine that caused the Ancient Mariner to exclaim, "Water, water everywhere, nor any drop to drink," into the purest of potable waters, and thereby rendering the sailor independent of fresh water storage.

With respect to the application by the engineer of electrical science, it is within the present generation that electricity has passed from the state of a somewhat neglected scientific abstraction into practical use: first, by the establishment of the land telegraph, then by the development into the submarine cable, by means of which any one of us visitors here in Canada may be in instant communication with his own country, and may be so without a selfish exclusive occupation of the cable, for once more the application of science has solved that apparently impossible problem of employing a single wire to be at one and the same time the transmitter of multiple electric messages, and messages in opposite directions. Then, thanks to the application of Faraday's great discovery of induced electricity, there has been, during the last quarter of a century, the progressive development of the dynamo-machine, whereby the energy of ordinary motors, such as steam-engines, is converted into electrical energy, competent to deposit metals, to (as has already been said) fuse them, to light not only isolated buildings, but extensive areas of towns and cities, and to transmit power to a distance, whether for manufacturing purposes or for the railway or tramcar; and thus the miracle is performed of converting a waterfall into a source of light, as at Sir William Armstrong's house, or into the origin of power for a railway, as at the Giant's Causeway. To the application of electrical science is due the self-exciting of the dynamos and the construction of secondary batteries, enabling a development of electricity to be continued for many hours. In the United Kingdom, general electric lighting, that is to say, the lighting of large sections of a town from a central station, has been stopped by the most unwise, because most unjust, conditions imposed by the Government General Electric Lighting Act of 1882. A new and meritorious industry, which should have been granted the same privileges as are accorded to other industrial undertakings needing Parliamentary powers, was subjected to this most unjust condition: that at the end of twenty-one years the public authority of the town or place lighted should have the option of buying the undertaking for the then value of the mere materials, and that if the authority did not choose to purchase (for it was not bound to buy), at every subsequent five-year period this option should re-arise; that is to say, that a new undertaking, which would require years for its general acceptance (for the public is slow to take up a novelty), was, after the experimental and non-paying stage had been passed, to be practically forthwith taken away for a mere fraction of the capital that had been outlaid if the undertaking paid, but was not to be taken away if it did not pay. Such, in spite of the teaching of Section F, is the condition to which our Government has arrived in respect of economic science. The next electrical matter I have to touch upon, that of the telephone and microphone, with which will for ever be associated the names of Graham-Bell, Edison, and Hughes, has, as regards the public use of the telephone, been all but similarly treated in the United Kingdom. It has been declared to be within the telegraphic monopoly given by Parliament to the Post Office nine years before the telephone was invented, and the power to use it depends entirely upon the grace and favour of the Post Office, a grace and favour not always accorded; and even when accorded, coupled with limitations as to distance, and coupled with a condition of payment of 10 per cent of the gross receipts by the companies to the Post Office as a royalty; and all this because Government has become a trader in electrical intelligence, and fears the competition of the telephone with its telegraphs.

No one in the ship-loving countries of England, Canada, and the United States, can refrain from feeling the warmest interest in all connected with navigation, and we know how frequently, alas! the prosperous voyage across the wide and fathomless ocean ends in shipwreck and disaster when the wished-for shore is approached, and when the sea is comparatively shallow. Except for the chance of collision, there is in a staunch ship little danger in the open ocean, but on nearing the shore, not only is the liability to collision increased, but shoals and sunken rocks render navigation perilous, and it is on the excellence of the lighthouses and lightships that (coupled with soundings) the sailor relies. These structures and appliances are confided to the engineer, and to be efficient they require him to be able to apply the teachings of Section A in optical science, and in the case of fogs, or as regards buoys at night time, the science of sound. I parenthetically alluded to soundings as one (indeed a principal one) of the safeguards of ships when approaching shore. It is important in these days of high speeds that these should be made with ease and without the necessity of stopping the ship, or even of diminishing its velocity. Sir William Thomson, by the application of the science of pneumatics, has enabled this to be done. Again, most important is it that the compass, midst all the difficulties attendant upon its being situated on an iron or steel structure, should be trustworthy. And here Sir William has applied the science of magnetism in his improved compass to the practical purposes of navigation.

To go to another important branch of engineering—water supply. The engineer dealing with a district to be fed from the surface will find himself very deficient if he have not the power of applying the science of meteorology to the work that he has in hand; he must know, not the average rainfall, for that is of but little use to him, but the maximum, and most important of all, the minimum rainfall over a consecutive period of years: the maximum so that he may provide sufficient channels and by-washes for floods; the minimum so as to provide sufficient storage. He must know what are the losses by evaporation, what are the chances of frost interfering with his filters and with his distributive plant.

Coming to the mathematical side of Section A—whether we consider the naval architect preparing his design of a vessel to cleave the waves with the least resistance at the highest speed, or whether we consider the unparalleled series of experiments of that most able Associate of Naval Architects, the late William Froude, carried out as they were by means of models which were admirable in their material, their mode of manufacture, with absolute accuracy to the desired shape, and their mode of traction and of record, we must see that both architect and experimenter should be able to apply mathematical science to their work, and that it is in the highest degree desirable that they should possess, as Froude did, those most excellent gifts, science and practical knowledge.

Again, the mathematical side of Section A has to be applied by engineers when considering the strength and proportion of boilers, ships, bridges, girders, viaducts, re-

taining walls, and in short the whole of the work with which an engineer is entrusted. Notable instances of great bridges will occur to all our minds, especially meeting as we are in this Continent of grand streams, Ead's St. Louis Bridge, Roebling's Niagara Bridge, and his and his sons' East River Bridge, Gzowski's International Bridge, and going back to our own land, Fowler and Baker's Bridge over the Forth.

Passing from Section A to Section B, there is evidently so much overlapping of these sections that a good deal that I have said in reference to Section A might properly have been reserved for Section B. The preparation from the ore of the various metals is in truth a branch of engineering; but to enable this to be accomplished with certainty, with economy, involving the not throwing away of that which is called the waste product, but which is frequently a valuable material, it is essential that the engineer and the chemist should either be combined in one and the same person, or should go hand in hand. In the manufacture of pig-iron it is absolutely necessary that the chemical constituents of the ore, the fuel, and the flux should be thoroughly understood, and that the excellence of the process followed should be tested by an analysis of the slag. For want of this chemical knowledge thousands upon thousands of tons of bad pig-iron have been made, and thousands upon thousands of tons were formerly left in the issuing slag. Similar remarks apply to the production of lead and of copper from the ores, and still more do they apply to that great metallurgical manufacture of the last few years—"steel." In the outset steel was distrusted because of the uncertainty of its behaviour, but the application of chemical science now enables the manufacturer to produce with precision the material required to fulfil the physical tests imposed by the engineer.

Reverting to the water engineer, the chemist and the microscopist have their sciences applied to ascertain the purity of the intended source, and, as in the case of Clarke's beautiful process, by the application of chemistry, water, owing its hardness to that common cause, carbonate of lime, is rendered as soft as the water from the mountain lake. Taking that other branch of engineering commonly coupled with water, viz., the supply of gas, the engineer is helpless without the application of chemistry. From the examination of the coal to be used, to the testing of the gas to be supplied, there is not one stage where chemical science is not necessary. The consumer requires gas which shall be as nearly as possible a pure hydrocarbon of high illuminating power, and it might well have been that a person to whom was delivered the crude gas as it issued from the retort would have said, "Certain things may be separated out more or less, but to practise on a wholesale scale the delicate operations which will be needed to cleanse the illuminating gas from its multifarious accompanying impurities is a hopeless undertaking, and must be so if for no other reason than this—the excessive cost that would be entailed." But what are the facts? Although I for one do not like to sit in a room where gas is burnt, unless special provision is made for taking away the products of combustion, the engineer of the present day, thanks to the application of chemical science, delivers gas to the consumer in a state of comparative purity (although it may have been made from impure coal) which but a few years ago would have been deemed impossible; and so far is this improvement from being attended with extra cost, that the residual products not now uncommonly all but pay the whole cost of the coal, and in some rare instances even leave a slight profit to go towards the charge for labour. Again, it is by the application of chemical science in the dynamite and the guncotton of the present day that the engineer is enabled to prepare submarine foundations, to blast away shoals, and to drive tunnels through rock of a character that cannot be dealt with by mere cutting machines. Equally to the application of chemistry is it due that there are hopes, by the employment of lime cartridges, of breaking down coal without that risk of igniting fire-damp which is attendant upon the use of gunpowder. I need hardly observe that much more might most pertinently be said on the way in which the engineer applies chemical science. In fact, those ways are so multifarious, that a volume might be written upon them, but I must pass on and ask you to consider how the engineer applies geological science, the science treated by Section C.

I have already spoken of the engineer supplying towns by water collected from the surface; even he, however, must have a knowledge of geology, for without it he will not know what places are apt for the huge reservoirs he constructs, nor where he can in safety make his enormous embankments. In this continent of vast lakes one feels it must excite a sensation of the ridiculous when a "Welsh lake" is spoken of, but I must ask you to believe that you are in Lilliput, and to imagine that the "Bala Pond" of eleven hundred acres in extent is really "Bala Lake," as it is called. Within a few miles of that, our friends at the other end of the Alantic steam ferry, the inhabitants of Liverpool, are now constructing under the engineering and advice of Mr. Hawksley, a waterworks which will involve the formation, I believe one may safely say the re-formation, of a lake, practically the same area as that of Bala, of some 80 feet in depth, and containing between the overflow and the point of lowest discharge nearly twelve thousand million gallons. This lake will be made by the throwing from side to side of the valley of a solid stone bank, 100 feet above the ground, 140 feet above the deepest part of the foundations, and 113 feet thick at its thickest. Contrasted with Lake Superior this new lake will be small, a thing demanding a microscope even, but the bursting of the wall would liberate a body of water sufficient to carry death and ruin throughout a considerable district. It is, therefore, in the highest degree important that whether he be constructing the solid stone wall, or the more common earthen embankment with a puddle trench, the engineer should so apply geological science as to ensure the safety of his work. But in those cases where the waterworks engineer has to derive the supply from underground sources, the application of this science is still more necessary; he must know whether he is likely to find a water-bearing stratification at all—if so, where it receives the rain from heaven, and the extent of the area which receives it; in what direction the water travels through it, what is the varying height of water in the different parts of the stratification giving the "head" to produce that travel; how far this height is likely to be affected by the pumping of the desired quantity; whether, if near the outflow into the sea, the pumping is likely to reverse the direction of the current, and to bring back brackish water, and whether the rocks are of such a character as to be liable to yield a water impregnated with iron or with lime, and whether these water-bearing rocks are accessible from the surface without the execution of costly and laborious work in passing through overlying stratifications of an unfit or it may be even of a dangerous character. It need hardly be said that the engineer when engaged in metalliferous mining, or in the extraction of coal or of petroleum, unless he applies the science of Section C, is but an haphazard explorer whose work is more likely to end in disaster than in success. Again, the engineer, when laying out a railway, has to consider the geological features of the country in determining the angles of his cuttings, and to determine where it becomes more economical to tunnel than to cut. Indeed, without the application of that science to engineering there are some enterprises on the feasibility of which the engineer would not be able to pronounce an opinion—a notable instance, the Channel Tunnel. The engineers, of whom I am one, said there is a material, the compact non-water-bearing grey chalk, which we have at a convenient depth on the English side and is of all materials the most suitable; if that exist the whole way across, success is certain. Then came geological science, and that told the engineer that in France the same material existed; that it existed in the same position in relation to other stratifications as it

existed in England; that the line of outcrop of the gault lying below it had been checked across; and that taken together, these indications enabled a confident opinion to be expressed that it was all but certain this grey chalk stratification did prevail from side to side. The engineers believed it, an intelligent section of the public believed it, and came forward with their money; large sums were expended in England and in France on the faith of the repeated declaration of the English Government (of both sides of politics), that so long as the nation was not called on to contribute towards the cost of the work, it would hail with satisfaction the improved means of communication between England and the Continent; the experimental works were carried on from both sides with the happiest results, and then, when success appeared certain, the whole work was stopped by the incredible suggestion that in the event of a war the soldiers of England, and the science of England, could not defend a couple of rat-holes, holes 14 feet in diameter and 20 miles long, situated far below the surface of the sea, having a rapid dip from the shore to a low point, gradually rising from there to the centre of the length of the tunnel, so that the English end could be flooded with sea-water in twenty-five minutes up to the soffit of the arch at the dip; and in consequence of this incredible and most-to-be-ashamed-of scare it is due that one of the finest instances of civil engineering work in connection with the science of geology, and as I believe one of the most useful works that has even been proposed, has been put a stop to.

To come to Section D, the botanical side of it is interesting to the engineer as instructing him in the locality and quality of the various woods that he occasionally uses in his work. With regard to that most important part of the work of D, which relates to "germs" and their influence upon health, the engineer deals with it thus far: he bears in mind that the water supply must be pure, and that the building must be ventilated, and that the excreta must be removed without causing contamination; thus the waterworks engineer, the warming and ventilating engineer, and the sewage engineer can (and do) all of them profit by the labours of Section D, and can by their works assist in giving practical value to the pure science of that section.

Section E, *Geography*. Probably in these days, when our kingdom at home and the old countries near us are all but full of the works of the engineer, there are few who take a greater interest in geography than he does, and I am quite sure there are none who make a more useful application of geographical knowledge for the benefit of mankind at large than does the engineer. Almost at the outset of this address I claimed to magnify Section G, on the ground that without the aid of its members we should not have had that practical lesson in geography which we have received by our visit here, a lesson that will no doubt be continued and amplified by many of us before we return to our homes. Whether it be by the ocean steamer or by the railway train, the enterprising geographical explorer is carried to or through countries which now, thanks to the engineer, are well known and settled, up to the beginning of the unknown and not settled; and thus his labours are lightened, he consumes his energies only upon his true work, brings back his report, which is, as I have said, studied by the engineer with a view to still further development, and thus turn by turn the geographer and engineer carry civilisation over the face of the world.

Now to come to Section F, which treats of Economic Science. The matters with which this section deals—birth-rate, death-rate, the increase or the diminution of populations, the development of particular industries in different localities, the varying rates of wages, the extent and nature of taxation, the cost of production, the cost of transport, the statistics of railway and of marine disasters, the consumption of fuel, and many matters which come within the purview of F, are of importance to the engineer. Guided by the information given him by the labours of this section, he comes to the conclusion that a work having a particular object in view should or should not be undertaken. With the information derived from the past he judges of the future; he sees what provision should be made for prospective increase of population or of industries; he sees the chances of the commercial success of an undertaking or of its failure, and he advises accordingly.

I do not propose to say anything about Section H, for I have dealt with it as being still included within D.

I trust I have now established the proposition with which I set out, viz., that not only is Section G the section of Mechanical Science, but it is emphatically the section of all others that applies in engineering to the uses of man the several sciences appertaining to the other sections—an application most important in the progress of the world, and an application not to be lightly regarded, even by the strictest votaries of pure science, for it would be vain to hope that pure science would continue to be pursued if from time to time its discoveries were not brought into practical use.

Under ordinary circumstances I should have closed my address at this point, but there is a subject which at this, the first meeting of Section G after the meeting at Southport, must be touched upon. It is one of so sad a character that I have avoided all allusion to it until this very last moment, but now I am compelled to grapple with it.

In the course of this address I have had occasion to mention several names of eminent men, many of them happily still with us, some of them passed away; but I doubt not you have been struck by the absence of one name, which of all others demands mention when considering physical science, and still more does it come vividly before us when considering the application of science to industrial purposes. I am sure I need not tell you that this name, which I can hardly trust myself to speak, is that of our dear friend William Siemens, whose contributions to science, and whose ability in the application of science, have for years enriched the transactions of this Section, and of Section A and B, for in him were combined the mechanic, the physicist, and the chemist.

But a brief year has elapsed since he quitted the Presidential chair of the Association, and, with us at Southport, was taking his accustomed part in the work of this and of other sections, apparently in good health, and with a reasonable prospect of being further useful to science for many valuable years to come. But it was not to be; he is lost to us, and in losing him we are deprived of a man whose electrical work has been second to none, whose thermic work has been second to none, and whose enlarged views justified him in embarking in scientific speculations of the grandest and most profound character. Whether or not his theory on the conservation of the energy of the sun shall prove to be correct, it cannot be denied that it was a bold and original conception, and one thoroughly well reasoned out from first to last.

I feel that were I to attempt anything like the barest summary of his discoveries and inventions, I should set myself a task which could not have been fulfilled had I devoted the whole of the time I had at my command to the purpose. I had, indeed, thought of making his work the subject of my address, but I felt that his loss was so recent that I could not trust myself to attempt it. There is no need for me to dwell further upon this most painful topic. He was known to you all, he was honoured and loved by you all, and by every member of this Association he had so faithfully served, and over which he had so ably presided; and he had enjoyed the respect and esteem of the best intelligence in England, the land of his adoption; of the Continent his birthplace; and of Canada, and of the United States, whose populations are always ready to appreciate scientific talent and the resulting industrial progress. It is not too much to say that few more gifted men have ever lived, and that with all his ability and talent he combined a simplicity, a modesty, and an affectionate disposition that endeared him to all.

I am sorry to conclude my address to you in this mourn-

ful strain. I have endeavoured to confine my allusions to our dear friend within the narrowest limits, but if I have overstepped these I trust you will forgive me, remembering that "out of the fulness of the heart the mouth speaketh."

ON THE

ELECTROLYSIS OF FLUORIDE, CHLORATE, AND PERCHLORATE OF SILVER.*

By G. GORE, LL.D., F.R.S.

By means of pure dilute hydrofluoric acid (prepared as described in *Phil. Trans. Roy. Soc.*, 1869, p. 196) and pure oxide or carbonate of silver, a rather strong solution of pure argentic fluoride was obtained, and was then acidified by addition of pure hydrofluoric acid, in order to fit it for electrolysis.

This liquid is a remarkably good conductor of electricity, and is decomposed with the greatest ease by employing electrodes of silver, and an electric current derived from a single cell composed of zinc and platinum in dilute sulphuric acid.

I have elsewhere (*Phil. Trans. Roy. Soc.*, 1870, p. 235), described some of the phenomena attending the electrolysis of a strong aqueous solution of this salt not containing any free acid, such as the extremely rapid formation of a very thick coating of beautiful and bright crystals of silver upon the cathode, soon becoming half an inch in thickness and rapidly extending over the bottom of the vessel to the anode, and metallically uniting the electrodes unless the deposit is frequently removed. The increase of these crystals is so rapid with a strong solution and current, that if the vessel is a small one it soon becomes half filled with them. There is, however, another phenomenon to which I now desire to call attention, viz., that whilst a thick and smooth anode of pure sheet silver in a suitable solution of potassic cyanide dissolves gradually away and retains its original whiteness, cohesive strength, and most of its original smoothness, until it has become extremely thin, a similar anode in the fluoride solution quickly becomes exceedingly rough, of a grey aspect, and very friable throughout its thickness, having lost its original degree of cohesive strength.

Imagining that this loss of cohesion might be due to some substance set free by electrolysis and absorbed by the silver, as in similar cases of absorption of hydrogen and other liberated ions, at metallic cathodes, I took a tube of pure silver, 2½ in. deep, ⅜ in. diameter, and about 1 mm. thick, closed at the bottom by pure silver, and employed it as the anode. The upper end of the cup being tightly closed by cork, through which was fixed a slender platinum tube, connected by an indiarubber tube with an open, slender, and bent glass tube containing mercury, in order to render manifest any diffusion of gas into the interior of the tube.

Under these conditions, the liquid was electrolysed until a large hole was corroded in the tube; no signs of gas or odour, however, appeared, nor was the cork which closed the tube bleached or blackened. I conclude, therefore, that the loss of cohesion of the silver was not due to diffusion of liberated fluorine, through the silver.

A solution of chlorate of silver was formed by adding to 1¼ ounce of aqueous chloric acid (containing as impurity traces only of hydrochloric acid or a chloride) ten grains of argentic oxide: it nearly all dissolved. The liquid was filtered and then electrolysed by means of electrodes of pure sheet silver and a current from two Smee's cells charged with a mixture of one vol. of sulphuric acid and fifty of water. Conduction was very free for a short time; the anode, however, soon became coated with a black film, probably of peroxide of silver, which appeared to stop the current. Silver was freely deposited at first. The deposit was loose and not very white. The anode corroded but slowly, and permanently continued nearly black. By employing one Smee's cell only, the deposit was more slow, and more coherent, and remained attached to the cathode. The solution requires a feeble current, a large cathode, and a much larger anode.

To form the solution of argentic perchloride, fifteen grains of oxide of oxide of silver were added to one ounce by measure of aqueous perchloric acid. It nearly all dissolved. The liquid contained either hydrochloric acid or a chloride rather freely. The solution was then filtered and electrolysed by means of a current from two Smee's elements feebly charged, and electrodes of pure sheet silver; copious conduction occurred. The anode quickly became black, as if peroxide of silver was formed, but the current did not much diminish. The cathode soon acquired a very bulky deposit of loosely adherent silky crystals of silver. The liquid was again filtered, and then diluted with half an ounce of water, and a current from only one Smee's cell now employed. The anode became less dark in colour; the conduction was still very free, and a smaller bulk of crystals was deposited. A wire of silver was now substituted as the anode, and the crystals removed. The anode rapidly corroded, and acquired a thick loose coating of black matter, which kept falling off; it then acquired a thick green coating, but evolved no gas. The solution is a remarkably good conductor. It requires a very large cathode and a rather small anode.

* Read before the Birmingham Philosophical Society, June, 1884.

ANALYSIS OF ANTIMONY ALLOYS, SUCH AS TYPE-METAL, CONSISTING OF LEAD, ANTIMONY, AND TIN.

By F. WEIL.

1. From 2 to 3 grms. of the comminuted alloy are treated with nitric acid in a boiling-flask; almost all the nitric acid is evaporated off, a large excess of pure hydrochloric acid is added, and the mixture is boiled until the fumes no longer turn iodised starch paper brown, or but very faintly so. Hydrochloric acid is again added, and a little potassium permanganate or chlorate, to make sure that all the antimony is dissolved as antimonic acid. The liquid is then boiled until the fumes no longer act upon the iodised starch paper, *i.e.*, until all the free chlorine is expelled.

The solution is then introduced into a narrow measuring glass, and filled up to the mark (200 c.c.) with hydrochloric acid and water containing much tartaric acid, and well shaken.

The antimony is then determined in 10 c.c. of the solution volumetrically with stannous chloride, according to the method of Weil (see "Fresenius's Quant. Analysis," 6 edit., vol ii., part 5, p. 542).

If the alloy contains very much lead it is better to proceed as follows, in order to have in the measuring glass a clear liquid not rendered turbid by lead chloride.

The flask which contains the insoluble stannic and antimonic acids suspended in nitric acid, is filled up with hot water, shaken up, and let stand. After the precipitate is completely deposited the clear solution of lead nitrate is drawn off with a pipette.

The precipitate is washed in the same manner with hot water, decanted, and the residue is boiled in the flask with much hydrochloric acid and some potassium permanganate or chlorate until all chlorine is expelled.

The liquid, along with the aqueous and hydrochloric solution of tartaric acid, is then poured into the graduated cylinder up to the mark of 200 c.c., and 10 c.c. are lastly titrated as above for antimony.

2. From 2 to 3 grms. of the alloy, finely divided, are again treated with strong nitric acid, and the lead is deter

mined as sulphate in the well-known manner, and in the well-washed residue the joint quantity of lead and antimony is determined by ignition and weighing as antimonic and stannic acids.

3. The antimony as determined in No. 1 is calculated as SbO_4 and deducted from the weight of the joint antimonic and stannic acids already found. The residue is the stannic acid.

This method has the advantage of evading the tedious and difficult separation of antimony and tin.—*Zeitschrift f. Analytische Chemie.*

SEPARATION OF ZINC FROM NICKEL.

By THOMAS MOORE.

THE usual method for the separation of the two metals by sulphuretted hydrogen is open to many objections, and it is only in the hands of experienced chemists that good results can be depended upon, as, unless the exact amount of sodic acetate is added, either some of the zinc will not be thrown down, or the precipitate of zinc sulphide will be contaminated with nickel sulphide. In the following process, however, I obtain the zinc sulphide perfectly pure, and without any of the difficulties always attending the neutralising of the solution with sodic carbonate.

Excess of acid is got rid of by evaporation, and the residue dissolved in from 20 to 25 c.c. water and completely precipitated with excess of ammonic sulphide; the precipitate is then dissolved in potassic cyanide, the solution being effected by heating. When completely dissolved, dilute to about 250 c.c., and, after adding a few c.c. of sodic acetate, acidify with acetic acid and raise to the boiling point. The zinc is thrown down as the sulphide, and, after standing a few hours, is washed thoroughly by decantation, using hot water containing a little acetate of sodium and a few c.c. sulphuretted hydrogen water, and finally converted into oxide by the usual process. The filtrate and washings are evaporated to dryness with aqua regia, and the nickel estimated in the residue by dissolving in water and precipitating with potassic hydrate and bromine, re-dissolving in dilute sulphuric acid, adding ammonia, and precipitating as the metal by electrolysis.

The results are very accurate, and as I have had considerable experience with it in its application to German silver analysis, I can appreciate the smoothness, cleanliness, and rapidity with which it works.

Erdington.

SOME NOTES ON THE REICHERT METHOD OF BUTTER ANALYSIS.

By LEROY W. McCAY, M.A., D.Sc.

HAVING been lately called upon to report on some samples of suspected butter, and having, during my examination, made quite a study of the Reichert method of analysis, it may not be out of place to here call attention to a few points, a knowledge of which may prove of value to those who have occasion to try the process for the first time.

(1). First, then, I found, in the beginning, considerable trouble in apprehending what the author means when he directs that the mixture of fat, caustic potash, and 80 % alcohol be heated in a flask and upon the water-bath, with constant shaking, until the soap no longer forms a foaming, smeary mass. Indeed a solution of the problem has been arrived at entirely by experience. What Reichert wishes to impress upon the chemist is that *an evaporation of the alcohol is essential.* Now, although upon a fulfilment of this condition the correctness of the method depends, not one word has the author to say which bears *directly* upon the subject. In fact, the word evaporation does not occur at all in the article. He seems to take it *for granted* that a complete evaporation of the alcohol is essential, but considers it as worth while to *call attention* to the fact that this is alone possible, providing the flask containing the soap be heated upon the water-bath, with constant and violent agitation, until the mass no longer exhibits a tendency to froth or foam. He has left out a most valuable and suggestive direction, and seen fit to introduce one the ambiguity of which must, I fear, unless attention be called thereto, prove a ready stumbling-block to many who have occasion to try the process for the first time. I insist, therefore, that Reichert, in his directions, fails to state with sufficient prominence the necessity of a complete evaporation of the alcohol. It is surprising how incompletely the method has been described by those who have had opportunity to try it. In truth, there has generally been no description at all, it being merely stated that Reichert's directions were followed. I know of four chemists who have experienced the same trouble that I have, and consequently it seemed proper to publish a word on the matter. The condition under consideration, however, being carried out, the process turns out to be fully as quick, easy, and accurate as it is claimed to be by its ingenious author, and, although less rapid and, to my mind, less satisfactory than the simple, beautiful, and elegant method of Dr. Koettstorfer, it certainly is very convenient and, on the whole, more trustworthy than that of Hehner.

(2). To get rid of the alcohol by merely heating upon the water-bath is no easy matter, and so I have endeavoured to hit upon some contrivance by means of which this difficulty may be obviated. I find that the alcohol is almost entirely removed, and that, too, in a very short time, by proceeding as follows: the flask containing the soap and residual alcohol is closed with a perforated cork through which passes a piece of glass tubing long enough to reach to about the centre of the flask, when the cork is in place, and, moreover, project a few inches above the end of the neck. This outer end of the tube is then connected with the suction pump by means of a piece of rubber tubing, and the flask firmly clamped in an upright position in the bath, the temperature of which is so regulated that the contents of the flask shall enter into a state of gentle ebullition. As soon as the smeary mass, upon shaking, no longer froths or exhibits a tendency to froth, the point is reached and the soap may be dissolved in water, decomposed with acid, and the distillation commenced.

(3). To avoid the violent bumping which is so marked during the process of distillation, and which so seriously interferes with the general method of procedure, Reichert recommends it as feasible to pass a slow current of air through the liquid in the retort. This, however, is troublesome, as will be evident at a glance. Ambuhl sought to steer clear of this difficulty by using bits of platinum and pumice stone, but entirely without success. Dr. G. C. Caldwell,* finding it inconvenient to use the stream of air, ventured to try a combination of platinum spirals and pieces of pumice, and with complete success. I have tried this gentleman's device and have found it to work admirably. Thus far I have made a great number of distillations, and in no case have I noticed an indication of what could be called bumping. The ebullition continues throughout the process perfectly constant, and the quiet manner in which the bubbles of vapour are given off at the surfaces of the bits of pumice attached to the spirals, resembles very much the gentle disengagement of the bubbles from the lead-loaded cork in the new Bunsen water-bath. I use three little spirals, a small piece of pumice being attached at either end of each coil. The spirals, with their attachments, are conveniently made by coiling a piece of ordinary platinum wire, about 7 to 8 inches long, around a stout stirring rod, passing each

* "Second Annual Report of the New York State Board of Health; 1881-1882." Butter, page 526.

end through a bit of perforated pumice and twisting fast. I also drop in two or three pieces of plain pumice. Dr. Caldwell, in his article, simply mentions the success attending his use of combinations of platinum spirals and pumice, without entering into detail; consequently, I trust I may be excused for dwelling at length upon the subject.

John C. Green School of Science,
College of New Jersey, Princeton, N.J.

CORRESPONDENCE.

COPPER OXYCHLORIDE AS A PAINT.

To the Editor of the Chemical News.

SIR,—There would seem to be a diversity of opinion amongst medical men as to whether Dr. Koch's bacillus, or microbe, be the cause or the result of cholera; but whichever way that may be, it is a remarkable fact that preparations of the two metals mercury and copper, which are admittedly more eminently destructive than any others to plant and infusorial life, should be among the most favourite remedies for that disease, and their efficacy very probably depends on these same destructive powers. True, among the forms in which mercury is employed, mercurous chloride (calomel) has always held a favourite place with doctors, and this is one of the least active preparations of mercury, but this has probably been due to the fact that, being less poisonous than any of the mercuric preparations, it has been found to be a readier means of introducing into the stomach a certain quantity of the metal without disastrous effects to the patient. If it be desired to administer copper, reduced metallic copper (copper precipitate) would probably, on this same principle, be found to be the safest and best form in which to administer it, as, if pure and well prepared, it may be given in considerable doses without injury. But just as the mercuric preparations are more active than the mercurous, so the cupric are more active than the cuprous or than metallic copper, and it would probably be found advantageous to paint the insides of water tanks with the oxychloride of copper (Brunswick green) or some other insoluble cupric salt, as a means of antagonism to the development of microbia. Mercuric salts would, of course, act equally well, if not better, but they might be considered to be dangerous, being so very poisonous, whereas cupric salts, though excessively inimical to plant and infusorial life, are even held by some to be not poisonous to man at all.

Though I should hardly be willing to go this length in view of the many notable and well accredited instances of poisoning by copper, I cannot but admit that copper acts less actively on the human system than had been supposed; but anyway, a paint made with so insoluble a salt as the cupric oxychloride could never make the water in the least unwholesome, much less dangerous. Of course this method does not pretend to be by any means a prophylactic against the presence of all microbia; it could only affect such as came in contact with the sides, or subsided to the bottom, and it would, at any rate, prevent all growth on the sides or bottom of the tank, and destroy such organisms as came into contact with them.

I thus propose it merely as in some sort a step towards sanitation, not to speak of it as a complete remedy. Iron pipes might also be so coated interiorly. We must not measure the activity of copper on microbia by its action on the human system. That which would kill microbia will often scarcely affect human beings, and *vice versa*, what would be inevitably fatal to a human being will often scarcely affect microbia. Thus a dose of copper, which is fatal to all growth, and to all the lower organisms, may scarcely affect the human subject. Borax and salicylic acid have a fatal effect on microbia and on fermentation, but are with no poisonous effect on human beings; while, on the other hand, in the presence of a dose of arsenic, which would be inevitably fatal to man, saccharine liquids will enter into fermentation, the action being only rendered a little slower; and bacteria will also live in such a solution. It is now usual to paint iron tanks with red or white lead, and, apart from the fact of lead paint not being over good for iron, we know that some water exerts a solvent action on lead. Where, then, the choice lies between lead and copper, as a basis of a paint for water tanks, the latter is most certainly to be preferred. However, if an iron tank be painted with a cupric salt, whatever it may be, it is necessary, above all things, that the copper paint be perfectly *isolated* from the iron beneath, if it is desired to be maintained in a proper state of efficiency, and this either by a spirit or benzoline varnish, or, which is better, a paint composed with a metallic oxide the metal of which is electro-positive to iron, so that it may not be reduced thereby. Zinc oxide, magnesia, or even common cement, make a very good basis for a paint for this purpose, but magnesia is by far the best and most durable of these.

The paint may be made up with either addition of the calcined magnesia to varnish, or drying oil, and a sufficiency of driers added in this latter case, as without them magnesia paint does not dry well, and on this, when sufficiently dry, the cupric paint should be applied.—I am, &c.,

F. MAXWELL-LYTE.

IRON COMBUSTION TUBES.

To the Editor of the Chemical News.

SIR,—In the Proposals for Uniform Methods for the Determination of Nitrogen accepted by the German Manure Manufacturers' Association it is stated that "The use of iron combustion tubes cannot be generally recommended. They are only allowable with the modifications described by Prof. Paul Wagner (*Chemiker Zeitung*, viii., No. 37)." Would any of your readers kindly inform me through your columns what these modifications are?—I am, &c.,

W. W. M.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—Having recently presented myself for examination in Chemistry, I am naturally anxious to know whether I am likely to be passed or *ploughed*. One of the questions asked me to describe the behaviour of certain metals with hydrochloric acid. I think my answer was correct in most cases, but I am still doubtful about antimony, and take the liberty of writing to ask if any of your readers can set my mind at rest on the subject upon which the doctors disagree very much.

Roscoe and Schorlemmer say that antimony is "easily dissolved by hot hydrochloric acid." (1879, part. ii., p. 305).

Roscoe says "Antimony is not attacked by dilute hydrochloric acid." ("Elementary Chemistry," 1877, p. 212.)

Kolbe says "Hydrochloric or dilute sulphuric acid have (*sic*) no action on antimony." (Humpidge's Translation, 1884, p. 252).

Watts (Fownes) says "Antimony is dissolved by hot hydrochloric acid." (1883, p. 531).

Fresenius ("Qualitative Analysis," Vacher, 1872, p. 149.) says "Hydrochloric acid, even boiling, does not attack antimony." Again ("Quantitative Analysis," Vacher, 1876, p. 154) "Hydrochloric acid has very little action on it, even when concentrated and boiling."

Miller ("Elements of Chemistry," 1868, p. 673) says—"When finely powdered it is dissolved by strong hydrochloric acid by the aid of heat."

I stated that antimony is but little affected by hydrochloric acid, so that I should be plucked by Roscoe, Schorlemmer, and Watts, and passed by Kolbe, Fresenius, and Miller.—I am, &c.,

A BENIGHTED STUDENT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Journal de Pharmacie et de Chemie.
Series 5, Vol. ix., March, 1884.

Simple Means of Detecting Albumen in Urine.—M. Geisler.—The reagent employed consists of two slips of filter-paper, the one steeped in nitric acid and the other in a solution of potassium mercuric iodide, prepared as follows:—Potassium iodide, 3·32 parts; mercuric chloride, 1·35; acetic acid, 20·00; distilled water, 40·00. The paper thus prepared is dried and cut in slips; to make use of it the two slips are steeped in the sample of urine in question. If albumen is present the urine becomes turbid. The process is sensitive, and an excess of the reagent does not interfere. It certainly precipitates other principles contained in urine, such as uric acid, mucine, alkaloids, &c., but it will always be easy to recognise the nature of the turbidity produced. The precipitate of uric acid redissolves on heating, the precipitates of alkaloids dissolve in alcohol; mucine forms small clouds in the midst of the liquid, whilst albumen is thrown down in heavy flocks.

Extraction of Colouring-Matters by Means of Solutions of Borax.—R. Palm.—Already inserted.

Saffron, Containing Alumina.—E. Schmidt.—The question is here not of a sophistication, but of a small quantity of alumina naturally present in saffrons from the South of France. The only plants in which alumina has been hitherto discovered are certain Lycopods and *Rubus arcticus*. The saffrons in question contain from 0·115 to 0·123 per cent.

Determination of Starch.—Mr. O'Sullivan.—From the *Journal of the Chemical Society*.

April, 1884.

Assay of the Peppers of Commerce with reference to their Sophistication with Olive-Kernels and Husks.—H. Rabourdin.—The author weighs out exactly a gramme of the sample and boils it continuously for an hour in 100 grms. distilled water and 4 grms. sulphuric acid, adding more water from time to time to make up for the loss by evaporation. The flask must be supported by the neck or it will be broken by the violent bumping. After boiling for an hour the liquid is allowed to cool, poured upon a plain double filter which has been previously well dried and tared. When the pepper contains olive-kernels they go to the bottom of the flask by reason of their higher specific gravity, and when the liquid is poured upon the filter they form upon the sides of the flask as it were a reddish sand, more or less plentiful. This character already is decisive, since pure pepper never gives these dense, reddish fragments. The flask is repeatedly rinsed out, and the filter with the residue are perfectly washed with boiling distilled water. It is then dried and weighed very carefully. The weight of this total residue forms the *coefficient* of the pepper. This value is variable for every kind of pepper, but for all pure kinds within very narrow limits, and is strikingly increased when the pepper is adulterated with kernels or shells. For white pepper the value is 0·175; Malabar, Tellichery, and Saigon peppers, 0·30; Alepy, 0·32; other pure peppers of commerce, 0·35. On the other hand, that of the olive-kernels is on the average 0·745, and that of the husks or shells 0·70.

Direct Volumetric Determination of Lime and Calcium Carbonate.—M. Prunier.—The difficulty of obtaining quickly a clear supernatant liquid, even at a boil, on precipitating a soluble calcium salt with ammonium oxalate has led to the abandonment of this reagent for the volumetric determination of calcium salts. This difficulty has been overcome by taking advantage of the property of starch, added in infinitesimal doses, of promoting the deposit of precipitates, when boiled with the calcareous solution in question, such liquid being neutral or neutralised with pure ammonia. The standard solution is prepared as follows:—Pure ammonium oxalate, 35·50 grms., and water to form a 1-4th normal solution. The oxalate should be very dry, but not effloresced, and should leave no perceptible residue when ignited on platinum foil. If there are any doubts as to its purity the standard solution may be titrated with a solution obtained by dissolving at a boil 1 grm. pure calcium carbonate in dilute hydrochloric acid, neutralising afterwards with ammonia, free from carbonate, and adding water enough to make up 40 grms. of liquid. We take of it, with a graduated pipette, 10 c.c., representing 0·25 grm. calcium carbonate, and ascertain, in a manner indicated below, that they precipitate exactly at a boil 10 c.c. of the solution of oxalate in presence of a little starch. To determine calcium carbonate in complex products, *e.g.*, limestones, we make a solution at 1-40th by stirring up in a tared flask 1 grm. of the mineral finely powdered with 10 grms. of water, pouring then upon it 3 c.c. of hydrochloric acid and boiling the whole for a few moments. There are then added 20 grms. water, mixing and neutralising with ammonia free from carbonate until it gives a slight blue tint to red litmus. It is then made up to 40 grms. with distilled water and filtered. With a graduated pipette there are measured off 10 c.c. of the filtrate (=0·25 grm. limestone) which is introduced into a test-tube, 2 to 2·5 centimetres wide and about 20 to 25 in length, after having wiped the outside of the pipette with blotting-paper, so as to have merely the exact 10 c.c. To determine the lime in such products as fat or lean limes, cements, &c., where it is associated with other elements, the substance in question is dissolved in the same manner as limestone, but making the solution at $\frac{1}{50}$, and introducing into the test-tube only 7 c.c. instead of 10 c.c. In either case there is added to the solution a small quantity of starch powder (about 1 centigrm.), and the whole is heated to incipient ebullition, turning the tube round to distribute the heat evenly and avoid bumping. Then by means of a Mohr's burette, graduated into tenths of a c.c., and fitted with a delivery tube so long as to descend into the test-tube almost to the level of the solution, there are run in at once 4 to 5 c.c. of oxalate. It is heated again, shaken up, let settle for one or two minutes, and the oxalate liquid is then gradually added in small fractions until the precipitation ceases. Towards the end of the operation, when the turbidity produced on adding the oxalate diminishes in intensity, the standard solution is dropped in with the orifice of the delivery tube lowered almost to the level of the liquid, so that the falling drops may not stir up the deposit. The supernatant liquid may be examined as to its transparency by placing it against a black ground near a window. If there is formed on the surface of the liquid a persistent froth, which renders the end of the reaction difficult to detect, it may be removed by adding a few drops of strong alcohol and heating the upper part of the liquid column. The percentage of calcium carbonate or of lime is given at once and without calculation by the number of tenths of a c.c. of the standard solution employed to precipitate all the lime. The temperature of the solution during the analysis should not fall below 15°, or the ammonium oxalate may crystallise.

Action of Copper upon the Human Economy; History of a Workshop and of a Village.—MM. A. Houles and de Pietra Santa.—The authors show that persons living in an atmosphere of copper dust are not subject to any special diseases; that the "copper cholic"

described by writers of the last century does not exist, but that workers in copper enjoy no immunity from cholera and typhoid fever.

On the Powders of Meat.—M. Yvon.—A continuation from the last number.

MISCELLANEOUS.

Appointment.—Mr. William M. Hamlet, F.C.S., has been appointed by the Board of Technical Education, Sydney, N.S.W., Lecturer on Practical Physics and Examiner in Physics at the Sydney Technical College.

South London School of Pharmacy.—The following is the list of successful competitors at the School examinations, held from the 26th June to the 5th July, 1884:—Senior Chemistry—Medal: R. Wilkinson; Certificates,—(equal): D. Arnott, and J. Jackson. Junior Chemistry—Medal: W. Rushton; Certificate—W. Holme. Botany—Medal: T. J. Clark, Certificate—R. Atkinson. Materia Medica—Medal: W. Holme; Certificate—T. J. Clarke. Pharmacy and Practical Dispensing—Medal: F. E. Brown; Certificate—W. Rushton. Extra Certificates of Merit: Messrs. Coleman, Cooper, Jackson, Kingan, Matthews, Taylor, Ward, and Williams.

The Chemical Laboratory of Wiesbaden.—In the Summer Term, 1884, there were 84 students on the books. Of these, 54 were from Germany, 6 from England, 6 from Russia, 4 from North America, 3 from Austro-Hungary, 2 from Luxemburg, Holland, Belgium, and Switzerland, and 1 from France, Spain, and Sweden. Besides the director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect F. Brahm. The assistants in the intsruction laboratory were 2 in number, in the private laboratory 12, and in the Versuchsstation 2. The establishment has been enlarged by a special department for hygiene and bacteriology, directed by Dr. med. F. Hueppe. During the last term, besides the scientific researches, a great number of analyses were undertaken in the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bones.—Would any of your readers inform me by which method in this country (especially in Lancashire) artificial manure and glue are produced from bones? Has muriatic acid yet been employed for this purpose, and to what extent?—L. Hundeshagen.

Indelible Ink.—I find that about 1 part of naphtha mixed with 2 parts of coal-tar makes a marking-ink for linen and cotton fabrics which for indelibility cannot be surpassed. It has also the great advantage of being in one mixture, and will keep if kept corked any length of time. It has the disadvantage, however, of being too faint. Could any of the readers of your valuable paper suggest any means of darkening the colour?—T. Wilson.

Erratum.—P. 26, col. 1, line 11 from top, *for* "more of the silica" *read* "none of the silica."

UNIVERSITY COLLEGE, LONDON.

ANALYTICAL CHEMISTRY.

The Laboratory of Analytical Chemistry, under the superintendence of Professor Williamson and Assistant Professor R. T. Plimpton, will re-open on Thursday, October 3rd.

For information as to other Courses on Chemistry, &c., apply to the Secretary of the College.

TALFOURD ELY, M.A., Secretary.

UNIVERSITY COLLEGE, BRISTOL.

CHEMICAL DEPARTMENT.

Professor—W. RAMSAY, Ph.D.
Lecturer—SYDNEY YOUNG, D.Sc.

The SESSION 1884-85 begins on 7th OCTOBER. Lectures on Inorganic, Organic, Advanced, and Technical Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening, Lectures on Inorganic Chemistry at reduced fees are delivered; and a Special Course of Lectures on Technical Chemistry is also given, with the co-operation of the Worshipful Company of Clothworkers. A Correspondence Class especially adapted for those engaged in the Clothworking and Dyeing Industries will begin in October. Several Scholarships are tenable at the College. Calendar, containing full information, price 1s. (by post 1s. 3d.) For prospectus and further information apply to the Registrar.

INSTITUTE OF CHEMICAL TECHNOLOGY
AND
ANALYTICAL LABORATORY,
5, 9, and 11, Philadelphia Chambers, Hackins Hey, and 3 and 12 A, Ashton Chambers, Hackins Hey, Liverpool.

PRINCIPAL—A. NORMAN TATE, F.I.C.

Designed for the examination, for scientific, commercial, and industrial purposes, of substances used and produced in the Arts and Manufactures, and found in Commerce; and for the instruction of Students in Chemistry and the allied sciences in their relation to industrial and commercial pursuits.

The Laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and Students' work.

Students' fees, fifty guineas per annum.

In addition to their chemical studies, Students who desire it can enter upon a course of instruction calculated to afford them knowledge useful in the erection and arrangement of manufacturing buildings and plant, and construction of apparatus. Special fees are charged for this course.

All communications should be addressed to Mr. A. Norman Tate, 9, Hackins Hey, Liverpool, as, owing to similarity of surname with that of the principal of another chemical establishment in Liverpool, misconception and mistakes have arisen.

COLLEGE OF APPLIED CHEMISTRY, KIEL.

This Institution affords special facilities for obtaining a thorough practical knowledge of the Manufacture and Analysis of Technical Products, as well as of the Analysis of all articles of Food and Drink.

Commencement of the Winter Season, 15th of October.

Prospectus with full particulars on application to the
Director, DR. SCHNUTZ.
Reference, Mr. LOUIS SIEBOLD, F.I.C., F.C.S., Carr Bank, Bury, Lancashire.

CHEMICAL LABORATORY,
WIESBADEN, GERMANY.

Director—Prof. R. FRESENIUS, Ph.D.

Practical Instruction in the Laboratory .. .. Prof. R. FRESENIUS, Ph.D.; H. FRESENIUS, Ph.D.; W. FRESENIUS, Ph.D.; E. HINTZ, Ph.D.

LECTURES.

Experimental Chemistry (Inorganic) H. FRESENIUS, Ph.D.
Experimental Physics .. .. W. FRESENIUS, Ph.D.
Organic Chemistry .. .. E. HINTZ, Ph.D.
Chemical Technology .. .. } E. BORGMANN, Ph.D.
Microscopy, with exercises in microscopic work .. .. }
Chemistry and Analysis of Foods .. } H. FRESENIUS, Ph.D. E. BORGMANN, Ph.D. W. FRESENIUS, Ph.D, and E. HINTZ, Ph.D.
Hygiene: practical exercises in Bacteriology .. .. } Dr. med. F. HUEPPE.
Technical Drawing, with exercises .. F. BRAHM.

The next Session commences on the 15th of October. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. Kreidel's Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

THE CHEMICAL NEWS.

VOL. L. No. 1297.

ON SOME REACTIONS OF SILVER CYANIDE.

By CHARLES L. BLOXAM.

WHEN concentrated nitric acid is poured on precipitated silver cyanide, hydrocyanic acid is evolved, and, on boiling, the cyanide is entirely dissolved, the solution depositing crystals of silver nitrate on cooling; but if the solution be decanted when only a portion of the precipitate has dissolved, it deposits, on cooling, minute needles which mat together in a remarkable manner when the liquid is stirred. The formation of these needles on a glass microscope slide was recommended by me in a former communication for the identification of silver cyanide, and they can be distinctly perceived even with an inch objective. They are identical in appearance with the so-called silver nitrocyanide obtained by dissolving silver cyanide in silver nitrate which I had shown to have the composition $AgCN.2AgNO_3$. A quantity of the crystals from the nitric acid solution was freed from mother-liquor by pressure in filter-paper till dry, and decomposed by water, when amorphous silver cyanide was left, and silver nitrate passed into solution. Two different crops of crystals gave 21·5 and 22·44 per cent of Ag as AgCN. The above formula requires 22·78 per cent. The residue left by the nitric acid was a mixture of the needles with some unaltered silver cyanide, the silver nitrate contained in it amounting to 53·4 per cent. When silver cyanide was left for about twenty hours under cold concentrated nitric acid, about half of it had become converted into needles of nitrocyanide. The concentrated acid (1·4) diluted with an equal volume of water appears the most suitable for dissolving silver cyanide as nitrocyanide when boiled.

Precipitated silver cyanide, treated with a strong solution of sodium carbonate in the cold, loses its curdy appearance, and becomes granular. Under a quarter-inch objective, the edges of these granules exhibit minute needles, which become more distinct after some hours. On boiling, the silver cyanide becomes grey, and is converted into a mass of minute needles strongly matted together; the boiling solution, decanted into a beaker, deposits needle-like crystals in abundance. These crystals exhiblt all the reactions of silver cyanide, and the mother-liquor contains only a trace of sodium cyanide.

The grey crystalline residue left after boiling the silver cyanide twice with a very strong solution of sodium carbonate, was well washed and dried at 100°. Its appearance under the microscope was unaltered, and it gave on ignition 81·3 per cent of silver; the cyanide would give 80·6 per cent, but the dark colour of the needles indicated slight reduction. Qualitative examination detected only cyanide and a little metallic silver.

The needles deposited from the sodium carbonate solution are voluminous, but shrink together into a small closely-matted mass when stirred. To obtain a sufficient quantity for analysis, 10 grains of silver nitrate were dissolved and precipitated by hydrocyanic acid, the precipitate well washed, drained, and heated to boiling with a solution of 300 grains of crystallised sodium carbonate in an ounce of water; the hot solution was decanted, crystallised by stirring, and the mother-liquor poured back on the undissolved cyanide, which was again boiled with it. Fifteen repetitions of this operation were required to dissolve all the silver cyanide. The crystals, which appeared very distinct under an inch objective, were thoroughly washed and dried at 100° without any alteration. On ignition they gave 80·46 per cent of silver instead of the 80·60 required for silver cyanide.

Potassium carbonate produces the crystals of silver cyanide more readily than the sodium salt. The cyanide precipitated from 10 grains of silver nitrate was boiled with a solution of 150 grains of potassium carbonate in an ounce of water; the decanted liquid deposited needles identical in appearance with those produced by sodium carbonate; the residual cyanide consisted almost entirely of matted needles, and dissolved completely on boiling ten times with the potassium carbonate. The mother-liquor from the last crystals contained only a trace of cyanogen. Silver cyanide, therefore, is practically undecomposed by boiling with very strong solutions of potassium and sodium carbonates, but is converted into small prismatic crystals, which are rather sparingly soluble in the hot solution of alkaline carbonate, and are entirely deposited on cooling.

King's College, London.
Sept. 19, 1884.

THE QUANTITATIVE DETERMINATION OF MORPHINE IN OPIUM.

By Dr. VON PERGER.

FROM 10 to 20 grms. of the sample in question, divided as finely as possible, are boiled for a short time with 15 to 30 grms. caustic baryta and about 150 to 200 c.c. water. The solution is separated by decantation and filtration from the residues, and the latter are boiled repeatedly with small quantities of hot water until a portion of the solution on evaporation no longer gives the reaction of morphine with molybdic sulphuric acid. In this process too frequent a repetition of the extraction should be avoided, and the volume of the filtrate will not be generally more than 400 to 500 c.c. Into this solution, which contains all the morphine, is passed a current of washed carbonic acid until the liquid is supersaturated with the gas, and the entire mass is evaporated to dryness in a capsule on the water-bath as quickly as possible.

The residue is moistened with absolute alcohol, removed from the capsule by means of a sharp spatula, introduced into a glass flask, and extracted with boiling absolute alcohol until a portion of the extract, evaporated to dryness on a watch-glass, no longer gives a distinct morphine reaction with molybdic sulphuric acid. For this purpose 300 to 400 c.c. are generally required. The clear, alcoholic filtrate is freed from alcohol by distillation in a small flask. When the volume of the liquid has been much reduced by pouring back the alcohol and distilling again the residue of the alcohol is completely expelled by placing the flask in a boiling water-bath.

The residue in the flask is resinous and sticky, of a yellowish brown colour. About 15 c.c. water are added, which has been mixed with a little ammonia, and the whole is allowed to stand for some time. The dark, resinous mass takes a light brown colour, and solidifies by taking up water. The transformation is promoted by stirring and rubbing with a glass rod covered with caoutchouc. The mass is then decanted through a small tared filter, and the finely-divided precipitate is brought upon the filter by repeatedly pouring back the filtrate. Finally it is washed with a little ammoniacal water, large volumes of liquid being avoided.

The filter is dried at 40°, and placed in a glass funnel which can be closed below. There is then poured upon it pure chloroform free from alcohol, which is left in contact with the contents of the filter for a considerable time; the tap is then opened and the chloroform run off. A fresh quantity is then poured on in its stead, and the operation repeated until if a portion of the almost colourless solvent is evaporated on a watch-glass, the residue dissolved in dilute hydrochloric acid, and the solution mixed with caustic soda-lye, merely a trace of turbidity appears; from 3 to 5 c.c. of the chloroform solution are sufficient for this purpose.

The filter is dried and weighed, and the product obtained is crude morphine. Its colour should be from a light-brown to a straw-yellow. It contains no narcotine, and is in many cases so pure that if covered with hydrochloric acid it dissolves with a yellow colour, and the solution, if shaken, congeals at once from the formation of morphine hydrochlorate.

In all cases, however, it requires to be purified. To this end the smallest possible quantity of very dilute acetic acid is poured upon the filter containing the crude morphine. If the weight of the crude morphine is from 1·0 to 1·5 grm., a mixture of 1·5 to 2 c.c. of acetic acid at 20 per cent with 20 to 25 c.c. of water will be sufficient. In order to promote the solution of the morphine as acetate the dilute acid may be heated to 30° to 50°. The filtrate is poured back several times into the filter, so as to dissolve all morphine. The filter is finally washed with 5 c.c. of water, and the yellowish brown filtrate is mixed with a few drops of a solution of potassium ferrocyanide, filtered again through the same filter, and washed with about 20 to 25 c.c. of water. The total volume must not exceed 50 to 60 c.c. The solution obtained is rendered alkaline with ammonia, and let stand for 24 hours. The crystalline morphine is collected on a dried tared filter, washed with ammoniacal water, dried at 102°, and weighed.—*Journal f. Praktische Chemie.*

ON THE EXAMINATION OF POTABLE WATERS.

By W. BACHMEYER.

Having been engaged for some months with the examination of potable waters I found the communication of A. R. Leeds (*see* Chemical News, vol. xlix., p. 150), very welcome. The necessity pointed out of a check-experiment with distilled water when determining organic matter by means of potassium permanganate in an acid solution led to a series of experiments which may possibly not be without value in throwing light upon the subject. The experiments and the conclusions deduced are therefore here briefly communicated. As A. R. Leeds prefers the determination of the organic matter in water in an acid solution to one in an alkaline solution, the experiments were confined to the former.

It was first ascertained that to give a distinct rose-colour to 100 c.c. of distilled water 2 drops = 0·14 c.c. of a solution of permanganate at $\frac{1}{50}$ were required.

The distilled water was prepared from a deep-well water, perfectly free from ammonia and nitrous acid, and when tested with Nessler's reagent and with starch-paste containing potassium iodide, it was found perfectly pure.

100 c.c. of this distilled water were heated to boiling, and mixed with 10 c.c. dilute (2 : 8) sulphuric acid, and then with 3 drops = 0·21 c.c. permanganate solution. After boiling for five minutes the colour was discharged, and for its reproduction 2 more drops = 0·14 c.c. were required,—a proof that 0·21 c.c. of the solution of permanganate had been consumed. This was confirmed in a second trial.

This experiment admits of several interpretations:—

1. The distilled water contains a reducing agent; 2, the acid employed contains a reducing agent; 3, both act simultaneously reductive; 4, potassium permanganate is gradually destroyed by boiling in an acid solution.

The following experiments were therefore undertaken to find the real cause of the phenomenon.

I. 100 c.c. of distilled water were heated to boiling, mixed with 10 c.c. of the above sulphuric acid, and the action of the water was observed on gradually adding single drops of permanganate solution ($\frac{1}{50}$) whilst the ebullition was maintained and the time of decolouration was accurately observed. On boiling for sixty-five minutes the consumption of permanganate increased to 0·63 c.c. Hence cause 4 does not suffice for the explanation of the phenomenon.

II. 25 c.c. of the water mixed with 10 c.c. of the above acid and further treated consumed 0·21 c.c. of permanganate in one case in twenty, and in another in eighteen minutes. The reducing agent is therefore not exclusively present in the acid.

III. 100 c.c. of distilled water treated as above and mixed with 0·63 c.c. permanganate were, after boiling for an hour (whereby decolouration had occurred), filled up with 100 c.c. of distilled water, heated again to a boil, and mixed with permanganate. After boiling for five minutes the quantities cousumed were respectively 0·14 c.c. and 0·2 c.c. Hence the cause of the reduction in the initial experiment lay mainly in the nature of the distilled water.

IV. 100 c.c. of distilled water, boiled for fifteen minutes with 10 c.c. sulphuric acid, and then mixed with 3 drops = 0·21 permanganate, were decolourised in three minutes. Consequently the reducing agent is not readily volatile, but its efficacy is opened up by boiling with acid.

V. 100 c.c. of distilled water with 5 c.c. sulphuric acid did not completely decolourise 0·21 c.c. permanganate on boiling for ten minutes. The same result was obtained when only 3 c c. of acid were used, but if 15 c.c. of acid were used 0·21 c.c. of permanganate were consumed in three minutes and 0·35 in ten minutes. Hence the energy of the reduction depends to a certain extent on the quantity of acid added.

VI. 10 c.c. of the acid of known strength were boiled and mixed with 3 drops = 0·21 c.c. of the permanganate solution. After boiling for five minutes the colour had disappeared. Hence, as might be expected, permanganate is more readily decomposed in a strongly acid solution.

VII. 100 c.c. of potable water gave the following consumption of permangate. In five minutes' boiling, respectively, 0·35 and 0·4 c.c. Again in thirty minutes boiling 0·8, 0·7, and 0·7. In five minutes' boiling the quantity consumed was 0·35 c.c.; in ten, 0·49; in twenty, 0·63; in thirty-two, 0·77; and in forty-seven minutes, 0·91 c.c. Hence the reductive power of the water is by no means exhausted in five minutes.

VIII. 100 c.c. of the above-mentioned potable water consumed on boiling for four minutes, 0·35 c.c.; nine minutes, 0·49 c.c.; fifteen, 0·63; and twenty-five minutes, 0·77 c.c. The energy of the reduction is here greater and the reductive values decrease with the time. It remains, however, undetermined how much must be ascribed to the greater quantity of acid.

In the determination of organic matter in potable water by means of permanganate in an acid solution the degree of decomposition is affected by: 1, the duration of the ebullition; and 2, the quantity and concentration of the acid employed.

In this process it is therefore advisable to fixed the time of boiling at thirty minutes; to use to 100 c.c. of water 10 c.c. of sulphuric acid (2 : 8) and, to deduct from the result obtained that quantity of permanganate which is found in an experiment with the purest distilled water in a *second* thirty minutes' boiling. Of course also the quantity of permanganate must be taken into account which is needed to colour the liquid. A too rapid evaporation of the water is to be prevented by the use of a flask with a long neck.

A quiet, steady boiling of the liquid, avoiding any vapour-tension is absolutely necessary. Of the permanganate solution used 1·14 c.c. corresponded to 1 c.c. solution of oxalic acid at $\frac{1}{50}$.—*Zeitschrift f. Analytische Chemie.*

Preparation of Ditolyl phthalide.—P. de Berchem.—This compound is obtained by means of Friedel and Craft's reaction, by heating to 100° in the water-bath a mixture of 100 parts phthalyl chloride, 450 toluene and 40 of aluminium chloride.—*Bull. Soc. Chim.*

ON THE SUBOXIDE OF MAGNESIUM.*

By G. GORE, LL.D., F.R.S.

BEETZ observed (*Poggendorff's Annalen der Physik und Chemie*, vol. c., xxvii., 1866, p. 45; also *Philosophical Magazine*, Oct., 1866, vol. xxxii., p. 269) that in the electrolysis of a solution of chloride of sodium by means of magnesium electrodes, a considerable quantity of black matter formed on the positive pole. He attempted to analyse it, but as the substance oxidised rapidly during the process of washing and drying, he had to abandon the attempt; in consequence, however, of this substance evolving hydrogen by contact with certain aqueous solutions, he came to the conclusion that it was a suboxide of the metal.

On many occasions whilst making experiments with other objects in view, I also observed a black substance form upon magnesium under the following conditions.

Magnesium in contact with platinum, both being immersed either in a solution of creosote, toluol, or xylol in vegetable naphtha. With the two metals in a solution of glacial acetic acid in absolute alcohol, the magnesium was rapidly corroded, and in one hour acquired the black coating, which increased during three days. The coating was instantly dissolved by dilute nitric acid, and the solution became green, evidently by deoxidation.

On other occasions I observed that rods of magnesium when in contact with either platinum, gold, palladium, silver, or iron, partly immersed in water and exposed to coal gas, carbonic anhydride, vapour of CCl_4, C_2Cl_4 (but not CS_2), became in one or two days more or less coated with patches of black matter. Aluminium under the same conditions did not produce the black substance.

By further experiments it was found that the black substance was formed, though less rapidly, when magnesium not in contact with those metals was similarly circumstanced, but not in any case with the vapour of the bisulphide of carbon. That vapour produced yellow solutions, probably in consequence of the alkalinity of the magnesic hydrate.

Magnesium alone in a mixture of absolute alcohol and glacial acetic acid also produced the black substance freely in a few hours; on removing the metal, washing and re-immersing it, the black deposit again occurred. In liquefied glacial acetic acid alone or in absolute alcohol, with either toluol or formic acid dissolved in it, very little of the black matter appeared. In a mixture of glacial acetic acid and either sulphuric ether or vegetable naphtha, the deposit was less than when alcohol was employed. With absolute alcohol and acetic ether, the deposit did not take place.

Ultimately it was observed that the black substance was formed when magnesium in water, either alone or in contact with the above-named metals, was exposed to the atmosphere, but most quickly when one of those metals, especially palladium, was in contact with it. With magnesium in contact with that metal, water, and vapour of CCl_4, much black deposit was formed during one hour.

In all these cases where the deposit took place it occurred within the first few days, and subsequently disappeared, whilst a white crust of magnesic hydrate formed. The black matter appeared also with magnesium alone in dilute solutions of the chlorides of potassium, sodium, ammonium, lithium, barium, strontium, calcium, and magnesium; also with the bromides of potassium, sodium, and ammonium; and with potassic iodide, each containing five grains of salt per ounce of water; also when connected with platinum in a solution of 1½ minim of hydrochloric acid per ounce of water. The solution of sodic chloride gave the largest amount, and showed a deposit in less than one hour. Magnesium was scarcely corroded at all in a weak solution of potassic sulphate, and acquired no black coating. All the results indicated that the black substance came from the magnesium and not from the liquids.

The black powder became white when heated to a temperature below redness. It dissolved with effervescence in dilute hydrochloric acid, also in sulphuric acid; it was probably also soluble in alkaline sulphides (see above). Traces only of iron were found in its hydrochloric acid solution by the usual tests. That solution was not precipitated, either by ferrocyanide, ferrid-cyanide, or sulphocyanide of potassium, nor was it, after being rendered slightly alkaline by means of ammonia, and ammonic chloride then added, precipitated by sulphide of ammonium.

By repeatedly immersing a plate of magnesium in a solution of about twenty grains of sodic chloride per ounce of water for an hour at a time until it acquired the blackish coating, and removing the coating by means of a hard brush wetted with dilute hydrochloric acid, a solution of the substance was obtained. The anhydrous salt formed by evaporation of this solution was subjected to a number of physical and chemical tests in comparison with ordinary magnesic chloride, but no difference was detected. The results, therefore, in every way confirm the conclusion that the substance was a suboxide of magnesium.

* Read before the Birmingham Philosophical Society, June, 1884.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING AUGUST 31ST, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, September 5th, 1884.

SIR,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from August 1st to August 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 168 samples of water, the whole were, without exception, clear, bright, and well filtered.

The excellence of the water supplied to the Metropolis during the past month was indicated by its state of aëration and by its freedom both from colour and from any excess of organic matter. Further, its perfect filtration was evident by the absence of even a trace of suspended matter in any one of the numerons samples submitted to examination.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ALLOYS USED FOR COINAGE.*

By W. CHANDLER ROBERTS, F.R.S.

IN the last lecture (*see* CHEMICAL NEWS, vol. xlix., page 188) we considered the changes through which the standard fineness of alloys used for coinage have passed in this country since the Norman conquest, and we saw that at a critical period of our numismatic history the silver coins contained only a quarter of their weight of precious metal, and therefore fully justified Latimer's attribution, "Your silver has become dross."

The questions we have now to deal with relate to no violent changes, and do not comprise the history of either national disaster or national success; but they have a certain importance of their own, as they refer to the methods by which standard fineness can be recognised and maintained.

The want of a method for ascertaining the degree of purity of gold and silver, or for determining the amount of precious metals present in their alloys, must have been felt as soon as the use of metals for currency was established. The history of assaying has yet to be written, but in rapidly reviewing the methods of assay which have been practised or proposed, it will be well to consider them in an order that is in the main chronological, but which enables the physical methods, as distinguished from the chemical, to be dealt with first.

The nation for which the honour of striking the first coins is claimed, gave its name to the "Lydian stone," or, as it is called in more recent times, the "touchstone." It is a dark basaltic rock, of fine texture, upon which a fragment of precious metal readily leaves a streak when drawn over its surface. The comparison of the streak left by the gold to be tested with similar traces derived from alloys of known standard and composition, afforded a ready means of ascertaining, approximately, the fineness of the metal under examination; while further insight into the character of the alloy was gained by submitting the streaks to the solvent action of an acid. There is an abundant literature† showing the degree of accuracy that may be attained by means of this stone; its use has survived for approximate assays until the present day.

Then, again, there was the method of ascertaining the purity of metals by their density, as compared with that of water, devised by Archimedes, B.C. 212, which is applicable to both gold and silver, and is still often resorted to when the metal to be examined must be preserved intact. The usefulness of density, as affording a trustworthy indication of standard fineness, has often been pointed out, notably by W. Symonds,‡ in 1756, and more recently by Dr. O. Broch.‖

The possibility of ascertaining the standard fineness of alloys by the aid of electricity long ago occupied the attention of physicists. In 1823, Becquerel§ suggested that trustworthy indications might be afforded by the electromotive force developed when the alloy to be tested is placed in an exciting fluid together with an alloy of known composition. The subject was partially investigated by Oersted,¶ in 1828, and its practical importance was further pointed out by Gay-Lussac,** in 1830. In 1878, the use of magnetic induction for indicating the composition of alloys was suggested by Professor Hughes,†† who showed incidentally that the induction balance affords a ready means for detecting counterfeits, and I have elsewhere pointed out the degree of accuracy of which this instrument is susceptible.‡‡ The method which involves the use of the spectroscope also deserves mention here, although it is, as yet, more delicate than trustworthy.*

These physical methods, both ancient and modern, are open to the objection that the uncertainty of the results they afford increases with the complexity of the alloys under examination; and further, the indications are complicated by changes in the physical state of the metals, produced either by hammering or annealing.

Pliny states that in his time a method was in use for estimating the amount of silver in an alloy of silver and copper, by the degree of discolouration or blackening which attends the heating of the alloy in air. This method, long practised in France, and known by the name of *essais à la raclure* (scrapings), or *à l'échoppe*, is described by Rochon,† who says that it was generally recognised in the Roman mints in the time of Marius Gratidianus, triumvir of the money, and later by Chaudet,‡ who gives a table showing that silver of the English standard (925), when heated to low redness in a muffle, becomes uniformly grey-white, while intermediate tints are produced by heating lower alloys, until the standard used for the French subsidiary coinage (835), is reached. As this becomes quite black under the treatment, the process ceases to be useful for alloys of lower standard.

In very early times the need must have been felt of some chemical method of isolating the precious metals—of separating them, that is, from their base associates, so that the gold or silver, when purified, could be weighed, and the amount originally present in the mass deduced by calculation.

The crude method of assay, already described, which depends on the change of colour produced by oxidation of the baser constituent of an alloy, leads up to the method used from very early times, which also depends on the principle that precious metals will resist oxidation, while the metals with which they are usually associated will not.

Its main outlines may be indicated as follows. When lead is melted with free access of air, a readily fusible substance forms upon its surface. This substance may be allowed to flow away, or, if the metal is contained in a suitable porous receptacle, called a cupel, the fusible oxide sinks into this containing vessel; in either case the oxidation of the lead affords a means of separating it from precious or inoxidisable metals, if any be originally present in the lead. I found lead in the ancient ornaments both of gold and silver, which Dr. Schliemann permitted me to analyse, and Pliny teaches that the Roman metallurgist used lead for the purification of gold and silver, for he says, "excoqui non potest, nisi cum plumbo nigro aut cum vena plumbi." The greatest of the early alchemists, Geber, who died in A.D. 777, knew perfectly that the lead "acquired a new weight" when heated in air, and I have elsewhere‖ tried to show how important the recognition of this fact was to the whole fabric of modern chemistry; it is not a little interesting that, among the very first experiments recorded by our own Royal Society, is a metallurgical series relating to the weight of lead increased in the fire on the "copels" at the assay office in the Tower, the account being brought in by Lord Brouncker, in February, 1661.§

The interest of the art of assaying, from a purely scientific point of view, was generally admitted in the 17th century. Lazarus Erckern, for instance, described it as "the very inlet and mother of many other honourable and profitable sciences," while William Badrock,¶ apparently regarding the art as an element of general culture, pleads its claims to be studied by "all gentlemen."

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* Cantor Lectures delivered before the Society of Arts.

† "De re Metallica," by George Agricola. Lazarus Erckern's work, translated by Sir John Pettus, 1683, chap. ix., p. 130.

‡ Essay on the weighing of gold, &c. London, 1756.

‖ *Norwegian Nyt. Mag. für Naturvsk*," Christiania, 1876.

§ *Ann. de Chim et de Phys.*, vol. xxiv., p. 343.

¶ *Ibid.*, vol. xxxix., p. 274.

** Instruction sur l'Essai des Matières d'Argent par la voie Humide.

†† *Proc. Roy. Soc.*, vol. xxix., p. 56.

‡‡ *Ibid.*, and *Phil. Mag.*, [5], vol. viii., p. 50. Tenth Ann. Report of the Mint, p. 46. 1879.

* *Phil. Trans. Royal Society*, vol. clxiv., p. 495. 1874.

† "Essais sur les Monnoies," p. 17. 1792.

‡ "L'Art de l'Essayeur," p. 77. Paris, 1835.

‖ Introductory Lecture to the course of Metallurgy at the Royal School of Mines, Session 1880-81.

§ MS. Register Book of the Royal Society.

¶ Author of a "New Touchstone for Gold and Silver Wares," p. 31. London: 1679.

Having shown the great amount of interest attached to the subjects, I will now return to the actual practice of the art as a metallurgical operation.

Geber, the Arabian, gives, if medieval translations of his works are to be trusted,* a sufficiently accurate description of the process to enable it to be conducted at the present day with no other aid than his; but it must be remembered that it was the object of the alchemist to distinguish silver from gold, and to isolate the metals, rather than to determine the amount of one metal present in admixture with another. Geber calls the process of cupellation the trial of the *cineritium*, and he points out, in the course of a description that deserves to be reproduced here, that "there are two bodies perfect, abiding the trial, to wit, *sol* (gold), and *luna* (silver). Take," he says, "sifted ashes or calx, or powder of bones of animals calcined . . . moistened with water, and make the mixture firm and solid with your hands, and, in the midst of it, worked into a round flattish lump, make a round and smooth hollowness, and upon the bottom of it strew a small quantity of glass beaten to powder, which lay to dry. When dry, put your metal into the hollowness thereof, which you would try to prove, put coals of fire upon it, then blow with bellows upon the surface till the the metal flows; upon which, being in flux, cast part after part of lead, and blow with a flame of strong ignition." This is to be continued "until the lead is vanished," and precious metal is left "still or quiet, and you see it clean and clear in its superficies,"—that is, the lead has dissolved the oxides of the base metals, and has carried them into the cupel, leaving the gold or silver, or an alloy of both, in the form of a button on the cupel.

This operation, as described by Geber, would more nearly correspond to a refining operation conducted on a large scale, with a view to the extraction of silver from lead, rather than to the method of assay as practised at the present day on a few grains of metal.

The method of conducting assays, on what would at the present day be considered to be a very large sample of metal, seems to have been held to be necessary in the 12th century, for in the official trials of the coin in the time of King Henry II., 1154-89, the "Miles Argentarius" and the "Fusor"† are instructed to take before the Barons of the Exchequer a pound of "twenty solidi" of the coin, which they are to place on a "*vasculum ignitorum cinerum quod in fornace est.*" The metal resulting from the trial is then weighed, and the amount it has lost is noted, and, if it is considered that the result of the trial is inaccurate, or "too much metal has been lost, say by the boiling, or by being carried off in the lead" [*illud quasi plus justo consumptum fuerit ignis scilicet exæstuatione vel plumbi infusione*], then it is to be repeated.

The amount of metal which has, for at least two centuries, been taken for assay is 12 grains troy, and this weight, which is known as the "assayer's pound," has the same number of divisions as the troy pound; the fineness of any given weight of metal is, therefore, indicated by the results of an assay, without tedious calculation. It has been shown that the process was officially recognised in this country in the reign of Henry II., and in France the first official mention of it occurs about the year 1314. It is the only method of assaying silver practised at the present day at the English Mint, although another method is used for verifying the composition of its alloys.

With regard to the apparatus required:—In Geber's work "of furnaces" there is no mention or illustration of the "muffle" furnace, so that he seems to have conducted the process in a cupel surrounded by incandescent fuel.

Biringuccio (1540) gives illustrations and detailed descriptions of appliances which hardly differ from those now in use, and so does his contemporary Agricola.* Budelius† (1591) gives a drawing of a furnace which somewhat resembles the type still used in continental mints, except that the muffle, or oven, is placed close to the base of the furnace; and the "Sculptures" of Sir John Pettus, reproduced from the works of Lazarus Erckern,‡ show various forms of muffles and furnaces, some used by the ancient assayers, others adopted in the middle of the 17th century at Nuremberg, where the goldsmiths flourished so vigorously. He also gives an improved form of furnace, "made of armour plates," closely corresponding in its general arrangement with a furnace now lent by the Mint to the science collection at South Kensington, which is specially interesting, as tradition points to it as being the furnace used by Sir Isaac Newton in his experiments on cupellation when Master of the Mint. Several transitional forms of furnace between the old one just mentioned and those now used by the Mint‖ are still preserved in the Assay Office. The tongs and other tools incidentally used do not require special notice, as the changes that have from time to time been made in them have only rendered their forms more delicate and handy, and have hardly altered their general type.

With regard to the balances employed, it may be sufficient to point out that, for centuries, they have been constructed with great delicacy, and that they now turn with 2-1000ths of a grain, when loaded with 10 grains. In fact, the use of the balance in very early times, for the purpose of assay, absolutely demolishes the claim of quantitative chemistry to be considered of comparatively modern origin. The indications afforded by the balance as to the result of an assay are not absolute, as the process is liable to error from several sources, and needs to be controlled in the manner which will be described subsequently.

The point to bear in mind at this moment is, that if the silver has been associated only with readily oxidisable metals, especially copper, as is usually the case when silver coins are assayed, then it only becomes a question of providing the amount of lead necessary to furnish, by oxidation, sufficient litharge to dissolve the oxides and carry them away. If, however, the silver is associated with gold, the latter metal resists oxidation, and will remain on the cupel with the silver, for—again to quote Geber—it will in "no wise forsake it." The cupellation stage must then be supplemented by a "parting" operation,—that is, the silver must be dissolved away by some solvent which will leave the gold untouched, and for this purpose nitric acid is universally employed. If the silver contains but a minute quantity of gold, the presence of the latter will be indicated by a few specks of brown powder left at the bottom of the vessel in which the silver is dissolved; if, however, the silver contains about one-third of its mass of gold, and has been extended into a strip, the gold will remain after the action of the acid as a coherent band, retaining the original form of the strip, but much reduced in volume. This action of nitric acid on an alloy of gold and silver was certainly known to Geber and the early alchemists; but the first official mention of the use of the parting assay appears to be in a decree of Philippe de Valois,§ in the year 1343, confirming its use in the French Mint. The assay methods for silver and gold are analogous, in so far that both are purified by the action of a solvent; but the base metals are removed from silver by fused litharge, while in its turn silver is parted from gold by nitric acid. There is, then, this difference between the assay of gold and silver. In the case of the cupellation assay of silver the button of metal has only to be removed from the cupel, and when the adhering

* There is a good English edition of the 17th century, "The Works of Geber," translated by R. Russell. 1686.

† Quoted by Lowndes, "Essay for the Amendment of the Silver Coins," p. 155 (London, 1695), from the Black Book of the Exchequer, written in the time of Henry II., cap. 21, Officium Militis Argentarii et Fusoris.

* "De re Metallica."

† "De Monetis et Re Numaria, Coloniæ Agripp." 1591.

‡ *Op. cit.*, p. 17.

‖ A drawing of the modern furnace was prepared for Dr. Percy's work, "Silver and Gold." Part I., p. 256. 1880.

§ Boizard, "Traite des Monnoies," p. 176. 1692.

bone-ash has been removed by a brush it passes direct to the balance. The process would also be sufficient for gold if it contained no other precious metal; when, however, the problem is to ascertain by assay how much gold is contained in an alloy, which may contain silver, or platinum and other metals of similar properties, then care must be taken that the amount of gold believed to be present in the alloy does not exceed the one-third part of the mass, as a larger proportion of gold would protect the alloy from the solvent action of the acid, and the greater the amount of gold the less perfect would be the attack of the acid.

In any case the first stage of assaying a gold alloy, say a sovereign, is to melt it with such an amount of silver as shall yield a button containing rather less than one-third of its weight of gold.

For the sake of convenience, and for the incidental advantage that the solvent action of fused litharge removes copper and other impurities, the first stage of the assay of gold is conducted on a cupel, the object to be attained being mainly to secure a button of gold and silver in a convenient form for submitting to the subsequent operations. The alloying stage would, however, be just as effective if it were conducted in a small non-porous receptacle, such as a small crucible of glazed porcelain.

The subsequent operations are, flattening the button, annealing it, rolling it into a strip, and annealing it a second time. It is then coiled into a spiral, or cornet, and treated by two successive portions of nitric acid, in order to remove the silver; after this the spiral of spongy gold, which retains the original form given to the silver-gold alloy, is heated to redness. when it becomes bright, and is sometimes so coherent that it may be unrolled without fracture.

This is an outline of the processes of assaying: the precautions which are adopted with a view to secure accuracy remain to be considered. Inaccuracy in silver assaying mainly arises from loss of silver, which may disappear in small but variable quantities, either by volatilisation or by sinking into the cupel with the litharge. The amount of metal lost varies with the temperature, which is never uniform throughout the muffle; and the results of assays, as indicated by the balance, have therefore to be controlled by assays on pieces of metal of known standard, distributed in such a way as to represent the varying degrees of temperature throughout the muffle. The metal lost by any given check-piece is added to the assays in close proximity to it, and, as the amount of metal lost very often amounts to 1¼ per cent, the apportioning of the additions to be made demands great skill on the part of the assayer, who has also to decide from the appearance of the buttons whether they have retained lead or not, in which case they would, of course, be unduly heavy. In gold assaying, on the other hand, although, as Geber knew, gold resists the action of molten litharge better than silver does, some precious metal may be lost either by volatilisation or by retention in the cupel; but the chief sources of error are (1st), solution of gold in the acid used, which would reduce the weight of the cornets, and (2nd), retention of silver by the cornets; but these inverse causes of error may be combined without neutralising each other. Some means of checking the results must therefore be provided, and it would appear that for centuries implicit confidence has not been placed in the indications afforded solely by the assays, as comparisons have invariably been instituted between the pieces of metal taken for assays and standard trial plates, or pieces of known composition, assayed side by side with the coins, so that any error affecting the coin assays also affects the check-pieces, and therefore the error can be allowed for.

The trial plates by which silver and gold coin have been tested possess, it seems to me, an amount of interest that can hardly be over-rated. The oldest of them to which a date can be assigned is a silver plate, imperfectly impressed with the dies of a coin of the time of Henry III. (1216-1272). A silver plate is alluded to as follows, in the *Rotulus de Moneta*, of the 7th and 8th years of King Edward I.:—"Premerement qe hom doit fere un estandart, qe doit demorer al Escheker, ou en quel lieu qe nostre seignor le Roy vodra"; and in 1326 there is a record of the provision of two silver-plates for testing the silver coined by King Edward II. for his Duchy of Aquitaine, "one plate to be of the just weight before the fire, and the other such as it (the metal tested) ought to be after the assays."* This is interesting, because it seems to point to the fact that the amount of silver which should be "lost in the fire" had been experimentally determined at that early period. Many of the old trial plates were formerly kept in the Pyx Chapel Abbey, Westminster Abbey, almost the only relic which remains of the church built by Edward the Confessor; and on the altar tomb believed to be that of Hugolin, the first Chancellor of the Exchequer, there is a circular dish-shaped cavity on which a small furnace may have rested, if,† as is probable, the trial of the Pyx was at one time conducted in this building. The trial plates were removed in 1842 from the Pyx Chapel to the office of the Queen's Assay Master in the Mint; and I am fortunate in being able to offer to the Society photographs of some of the more interesting of these. The trial plates were always divided into several portions, and, like the old Exchequer "tallies," this division was effected in rough serrations, so that portions of the original plate entrusted to the different officers could be readily identified. Of those which are photographed the more interesting are probably No. 1, made in the 17th year of King Edward IV. (1477), and No. 2, which marks the introduction of the standard now in use, 916·6, by King Henry VIII. All the plates, however, possess peculiar interest, for in relation to the assays of the "alloys used for coinage" they are the signs of centuries of responsibilites, which I am fully sensible it is a privilege to be permitted to sustain.

An examination of a series of assays made of the trial plates shows that, although the standards of fineness were always prescribed by law, the plates have, nevertheless, at times been very inaccurate.

The imperfections of the gold plates are mainly due to sources of error which had been recognised, but which were ignored when the last plates were made; and it is well to explain, therefore, that plates were in former times authoritatively pronounced to be "standard" simply with reference to the results of an inaccurate process of assay. The process now consists in submitting an accurately weighed portion of the alloy to a rapid method of chemical analysis, whereby impurities are eliminated, and the precious metal thus purified is again weighed, but the method is complicated, and the accuracy of the result may be affected by the retention of impurities, or by an actual loss of metal during the process. The weight of gold as indicated by the balance will, in consequence, not represent the amount originally present in the alloy, and it is therefore necessary to control the results by assaying, side by side with the alloys under examination, "standards" or check-pieces the composition of which is known. As, however, any error in the composition of these checks will be reflected in the result of the assay, it is preferable to use pieces of pure metal corresponding in weight to the amount which the alloys to be tested are anticipated to contain.‡ Formerly such checks of pure metal were not

* "Ruding," vol. i., p. 209.

† *Notes and Queries*, Nos. 17, 19, 20, and 23. 1880.

‡ The corrections to be applied to a gold assay will be readily understood from the following formula:—

Let 1000 be the weight of alloy originally taken;

p. The weight of the piece of gold finally obtained;

x. The actual amount of gold in the alloy expressed in thousandths;

a. The weight of gold (supposed to be absolutely pure) taken as a check, which approximately equals *x*;

b. Loss or gain in weight experienced by (*a*) during the process of assay;

k. Variation of "check gold" from absolute purity, expressed in thousandths;

employed, and a small amount of silver varying from 2-10,000ths to 1-1000th part of the initial weight of the assay piece which remained in association with the gold was consequently reckoned as gold in the assay report. It follows, therefore, that even the more recent plates, when accurately assayed, are usually found to be sensibly below the exact standards which they were intended to represent.

The experiments made with a view to ascertain the composition of the standard gold plate prepared by me, in 1873, show that the greatest variation of this plate from the exact standard does not exceed the 2-10,000th part; but the use of even a fairly accurate standard plate is liable to be attended with error, as the actual amount of precious metal in the amount taken for the check-piece may exceed or fall short of the true standard. It follows, therefore, that the assay reports on portions of metal tested by comparison with this check may indicate the presence of too little or too much precious metal.

The objections to the use of a standard silver plate are far greater, as the alloys used for the silver coinage, in this and in other countries, are mechanical mixtures, the molecular arrangements of which are very peculiar, and, so far as my experience goes, a plate of the legal standard cannot be prepared of uniform composition.

With regard to the use of pure gold and silver plates, it should be pointed out that, if it were possible to obtain gold and silver of absolute purity, there would be no limits to accuracy in assaying, except such as arise from operations of a purely mechanical nature. Of course it is not possible to attain to chemical purity, and the presence of traces of impurity in the checks causes the results of assays made in comparison with them to indicate the presence of an amount of pure metal in excess of that actually present in the alloy; but as the converse can never be the case—that is to say, as the gold cannot be more than pure—no danger can arise from this cause, and the error can be easily allowed for.

The supplementary fine gold and silver plates, prepared in accordance with instructions I received from the Lords Commissioners of the Treasury in 1872, proved eminently satisfactory. I have not been able to prepare, or to obtain from any source, gold of greater purity, even in small quantities. The silver plate leaves little to be desired, although it is not quite as pure as silver prepared by M. Stas, in comparison with which it is as 999·95 to 1000.

In conducting official trials of the pyx, minute accuracy is secured by a final appeal from the standard plates themselves to pure gold or pure silver.

We are now in a position to consider another question, the importance of which has long been recognised by law, and that is, the difficulty of attaining an exact standard, either of weight or fineness, in the case of all the individual coins issued from a mint. The law has, for centuries, and in all nations, permitted a certain deviation from the exact standard. The amount of such "remedy," as it has always been termed in this country, has changed from time to time, but has gradually diminished as the art of coining has advanced.

It follows, that although the component parts of the alloy may not bear to each other with mathematical precision the proportion prescribed by the regulations under which they are manufactured, they may, nevertheless, be considered to be of standard fineness. The earliest reference to a "remedy" I have met with is in the reign of Saint Louis, of France, 1253,* who granted an allowance of ¼ carat, for the fineness of Louis d'or. The mint agreement between King Edward I., and William de Turnemire,† in 1279, provides a remedy of 2½ dwts. on the pound troy of the silver coins. The law does not appear to have contemplated that the "remedy" should be systematically made use of as a source of profit, either to the Crown or to the Master of the Mint; it was rather considered to define the limits within which occasional variations of standard weight were unavoidable, and its true function has been well defined by the late M. de Jacobi, who, representing the Russian Government at the International Monetary Conference, held in Paris, in 1867, said, "the remedy is not an arbitrary stipulation, but is the limit of errors which belongs to every thought, to every chemical analysis, to every composition of alloy, and as such depends on the precision of the balances, and the methods employed in the fabrication of money. It may be determined rigorously by applying the calculus of probabilities."

The Mint indentures have been drawn up in just the same spirit. Remedies were accorded "because the said moneys may not continually be made in all things according to the right standard, but, peradventure, through default of the master or workers, they shall be found sometyme too strong or too feeble in weight or alloy," but this has not prevented a very different view having been taken of the privileges accorded by them, both to the Sovereign on the one hand and the Master of the Mint on the other. Queen Mary, for instance,‡ seems to have considered that the Sovereign was entitled to add as much base metal to the coinage as the law permitted, the sum so derived after deducting coinage expenses, to be considered seignorage, but she held that the Crown could not debase the coin, or increase the amount of base metal in it for private ends.

With regard to the action of Mint Masters in this respect, the history of the coinage abundantly proves that they frequently availed themselves of the "remedies," viewing them as a legitimate source of profit, or as a means, incidentally provided by their contracts, for reducing the current expenses of working; the best known case being probably that of Lonison, Master of the Mint in the reign of Queen Elizabeth.

The scale of remedies is fixed by the Coinage Act of 1870. At present we will only consider the remedy of fineness, which, in the case of the gold coin, has a range of $+\frac{2}{1000}$th, and in the case of silver $+\frac{5}{1000}$th. The gold coins of the nations who have joined the Latin Union have also a remedy of $\frac{3}{1000}$th. In America the remedy in the case of the gold coins has been reduced to $\frac{1}{1000}$th. "I do find," said Rice Vaughan,‖ writing in 1675, "that some men of great experience and understanding, even in this mechanical part, do hold that the moneys, both of gold and silver, may be made without any remedy to be allowed either for weight or fineness," bnt he subsequently adds, "I undertook this discourse of the mechanical part of money with scruple, so I do leave it with alacritie." It is certainly not the opinion of Mint officers of the present day that the remedies should be reduced to the lowest possible point, as this would involve the rejection and re-coinage of a large number of pieces before they could be permitted to leave the Mint; but, on the other hand, all agree that a persistent variation, however slight, above or below standard, has never been contemplated by law. The effect of such a mean variation would be remarkable.

If, for instance, the Mint were to issue sovereigns which were either persistently too rich or too poor in gold, to the extent actually permitted by law, a loss or profit

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Then the actual amount of fine gold in the check-piece—

$$= a\left(1 - \frac{k}{1000}\right),$$

and the corrected weight will be—

$$x = p - \frac{a\,k}{1000} \pm b,$$

b) being added or subtracted according as it is a loss or gain.
If (a) be assumed to be equal to (x) this equation becomes—

$$= \frac{p \pm b}{1 + \frac{k}{1000}}.$$

* Jean Boizard, "Traite des Monoyes," p. 25, 1692.
† Report on the Royal Mint, p. 41, 1849.
‡ Report on the Royal Mint, p. 39. 1849.
‖ "Discourse of Coin and Coinage," p. 91. 1675.

would accrue of over £2000 on each million coined, and a persistent variation of only $\frac{1}{10000}$th part would be equivalent to a profit or loss of £100a million. In Mint practice at the present day, even this comparatively small variation should be avoided, and the public trials of the pyx prove that it does not exist.

I have dwelt on these facts because the maintenance of rigid accuracy in the operations of coinage becomes of great importance in international currency. One Government might, as the late Professor Stanley Jevons pointed out, "coin money slightly inferior to the proper standard, and such money once introduced would, in virtue of Gresham's law, be difficult to dislodge." I admit, with him, that it is hardly to be supposed that a State issuing money under international obligations would wish to make a profit of one or two parts in a thousand, which the remedy would legally cover; but, nevertheless, the degree of accuracy with which the coinage is executed would be of much importance, for the following reason. A nation would be bound by the International Convention to withdraw and re-coin such coins of other nations as might be circulating within its borders at the time they were reduced by wear below the lowest weight at which their circulation would be legal, and it follows that any deficiency of standard which might exist would have to be made good by the nation on whom the re-coinage happened to fall, and a nation coining with rigid accuracy would suffer from the shortcomings of those who did not.

(To be continued.)

NOTICES OF BOOKS.

Chemical and Physical Analysis of Milk, Condensed Milk, and Infants' Milk-Foods: with special regard to Hygiene and Sanitary Milk Inspection. A Laboratory Guide developed from Practical Experience, intended for Chemists, Physicians, Sanitarians, Students, &c. By Dr. N. Gerber. Translated from the revised German edition and edited by Dr. Hermann Endemann. New York and London: Trübner and Co.

We have here a very complete manual of the analysis of milk. The author discusses in succession normal cows' milk, the physiological and other causes influencing this secretion, its general physical properties and chemical composition, and the composition of other milks, besides that of the cow. He then proceeds to the physical analysis with especial reference to its colour, consistency, odour, and taste. We come next to the microscopical examination, upon which the author does not lay much weight, though he agrees with Vieth in holding that microscopical examination may under circumstances furnish valuable indications if used for the detection of abnormal qualities in appearance, or behaviour, or the determination of foreign substances added to the milk. After directions for taking the specific gravity of samples he proceeds to the chemical analysis of milk. He determines water and solids, ash, phosphoric acid, albuminates and fat, and milk sugar.

The determination of total solids is effected by weighing 10 c.c. of milk in a dry covered platinum capsule, previously counterpoised. To the sample he adds absolute alcohol sufficient for coagulation, and then dries, first in the water-bath and then in an air-bath, at from 100° to 110°, until the weight of the residue is constant. He remarks that good milk should have 12·5 per cent of total solids. It will be remembered that Mr. Wanklyn—to whose published methods we find here not the slightest reference—gives 14·07 per cent as the mean of four determinations in which the utmost range of difference was only 0·04 per cent. Dr. Gerber does not, as far as we are able to perceive, refer to "solids minus fat" as a constant element in milk. He mentions, however, that milk must be considered inferior or adulterated when it contains less than 3 per cent of fat. This would show for solids minus fat 9·5 per cent, a figure which agrees very closely with Mr. Wanklyn's mean value, country milk—9·65 per cent.

The determination of the ash is effected by ignition in a muffle, and the phosphoric acid volumetrically by the uranium process.

Albuminates Dr. Gerber determines by Ritthausen's process slightly modified, *i.e.*, the precipitation of the albuminates and fats by a solution of copper sulphate and the subsequent extraction of the fat. For the determination of fat the author objects to treatment in an open vessel. Reference is made to the detection of mineral poisons, copper, lead, and zinc, which may be dissolved by sour milk from metal vessels.

On the subject of adulteration the author agrees substantially with English authorities. He considers that dealers mostly confine their operations to watering and skimming. He admits that the lactometer or lactodensimeter plays into the hands of sophisticators. Chevalier's creamometer is also justly condemned. The author insists that the indications of this instrument are very uncertain, and should never be brought forward before a court of justice, the cream even under identical conditions not rising equally, as the addition of water to milk makes the milk appear richer, and since the greater consistency of pure milk prevents the easy formation of the cream. The temperature also exerts an influence not only on the time required for complete separation, but also on the volume of the layer of cream.

Incidentally we meet with the following surprising passage; the author, speaking of the determination of specific gravity, says:—"All other instruments with scales differing from this (*i.e.*, from direct specific gravity) have been abolished on the European continent. It is only in England and through English influence in America that instruments with arbitrary scales are as yet in use!" As a commentary upon this outburst of Anglophobia we merely remark that Dr. Gerber, like numbers of other French and German writers, makes use of Beaumé's hydrometer (pp. 91 and 100), the essence of arbitrariness, and not convertible into direct specific gravity by a simple calculation like Twaddle's scale. The strengths of alcohol and ether, again, are given in this treatise, not direct in specific gravity but in degrees of the scale of Tralles.

Condensed milks and milk-foods are discussed at some length. Concerning the former the author remarks: "Provided that only good cow's milk be used, and that with an unvarying addition of sugar it is condensed to a proper and equal degree, no good reasons exists why condensed milk produced in any other country should not be equal to that produced in Switzerland."

He considers it important that a rationally compounded infants' milk food should contain at least 2 per cent salts, 5 of fat, and 13 per cent of albuminates, whilst one of the most highly recommended brands contains not quite 10 per cent of albuminates. Indigestion in children, he maintains, will increase when a food is lacking in albumen, but contains in its place soluble carbohydrates.

In discussing official regulations as to the sale of milk, the author states that the average figures obtained by the examination of the mixed milk of cows supplying any dairy has been found to be the same in all countries: he admits fluctuations and abnormalities in the milk of single cows. His standard (12·5 per cent total solids and 3 per cent fat), we have already noticed. We find here quoted an opinion by Prof. Feser, of Munich, which merits the serious consideration of sanitary authorities. He declares that "it is equally desirable to prevent the sale of milk which is below a certain standard as good milk, even if it be simply the unadulterated product of single animals reduced through insufficient and faulty feeding. . . . Ordinances passed for the prevention of adulteration would be powerless if it be lawful that milk may be adulterated before its production in the body of the animal, by injudicious treatment and feeding."

It is to be regretted that so useful a book should have been written in such bad English. On nearly every page we find expressions which are not idiomatic and words used incorrectly.

Proceedings of the American Pharmaceutical Association, at the Thirty-first Annual Meeting: held at Wasington, Sept., 1883. Philadelphia: published by the American Pharmaceutical Association.

THE first thing we notice in the present volume is a list of queries, some of them of great importance, proposed last year, and to which replies are expected at the present year's meeting. Among them we find required a paper on the tests for brucine in presence of strychnine and of strychnine in presence of brucine, together with a plan for the perfect separation of the alkaloids.

There is a short but significant paper on "Who is responsible for Adulteration?" Here, of course, we find a conflict of opinion. The merchant or the broker says "we have to supply adulterated drugs because the trade demand them . . . . we furnish an article as pure as can be had for the price." On the other hand, the retailer intimates that whatever the price paid the drug always comes out of the same barrel.

A case is mentioned where so-called cream of tartar consisted of 95 per cent gypsum and 5 per cent tartaric acid.

There is a memoir on the "stathmetometric" method of analysis, in which a standard solution is made up to a given weight instead of to a given volume. It is recommended as preferable to volumetry in climates like that of New England, where extremes of temperature prevail and changes of 50 degrees (of course Fahrenheit) frequently occur in a few hours. Here stathmetrometry (a clumsy word) has the advantage, as the correction for temperature is obviated. The apparatus used is, of course, a "Schuster's alkalimeter."

CORRESPONDENCE.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—If a "Benighted Student" would remember that Chemistry is nothing if not an *experimental* science, and would, with balance, test-tube, metal, and acid, ascertain for himself what is the fact, he would be able, without much expenditure of time or trouble, to "set his mind at rest" and the "doctors who disagree" at defiance.—I am, &c.,

J. H. P.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—Your correspondent, "A Benighted Student," whose letter appears in the CHEMICAL NEWS, vol. xl., p. 152, really appears to be less benighted than some of the authors whom he cites respecting the solubility of antimony in hydrochloric acid. In order to satisfy myself that the properties of that metal have not changed—like its atomic weight—since I was a student, I have made the following experiments:—

(1.) Antimony was very finely powdered, until it had lost its metallic appearance, and boiled with ordinary concentrated HCl in a test-tube for a minute or two: a little SbH_3 was detected by $AgNO_3$ at the mouth of the tube, but no H_2S. No diminution in the quantity of the metal was perceived, and the solution gave only a slight orange precipitate with H_2S water.

(2.) Antimony precipitated by zinc was treated in the same way, with a similar result.

(3.) 15·6 grains of the very finely powdered antimony were boiled for fifteen minutes in a covered beaker with a measured ounce of concentrated HCl (sp. gr. 1·16). The undissolved metal, washed and dried, weighed 14·9 grains, so that 0·7 grain, or about 4·5 per cent, of the metal had been dissolved.

This confirms the statement which the benighted one quotes from "Fresenius's Quantitative Analysis" (1876), that hydrochloric acid has very little action on it even when concentrated and boiling.

In his Preface to "Fresenius's Quantitative Analysis" the Translator states that the author has a most firm conviction that for inorganic chemistry the old notation is the simplest and the best. Is it possible that chemists in this country are more anxious to produce elegant and expensive books containing the last new "fad" in notation than to verify experimentally the statements which they put forth?—I am, &c.,

A PRACTICAL CHEMIST.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 9, September 1, 1884.

Researches on the General Course of Vegetation in an Annual Plant. Hydrocarbons.—MM. Berthelot and André.—This memoir does not admit of useful abstraction.

Comparison between the Electro-chemical and the Thermic Coloured Rings.—O. Decharme.—If we expose a plate of copper to the flame of a spirit-lamp, of a Bunsen burner, or better to the fixed and narrow jet of an enameller's lamp, there are produced upon the metal iridescent coronæ around the heated point. If the experiment is well managed there are obtained fixed coloured rings, apparently inalterable in the air. These thermic rings are quite similar to the electro-chemical rings of Nobili; like them they follow one upon another and are propagated in waves. In both cases the colours succeed each other in the same order, which is that of Newton's rings as seen by transmission. Multiple thermic rings may be produced by means of drums surmounted by 2, 3, 4, &c., gas-burners. These same pieces serve equally for the production of the electro-chemical rings by fixing in the fine openings of the tubes needles of steel of equal length for each system. The thermic rings, simple or multiple, approximate the more closely to the corresponding electro-chemical rings as the jets of flame are feebler and less oxidising.

Determination of the Wave-lengths of the Principal Rays and Bands of the Ultra-red Solar Spectrum.—Henri Becquerel.—The author gives a table of wave-lengths, expressed in millionths of a millimetre and states that the phosphorographic method, when the phosphorescent substances are suitably chosen, enables us to explore the ultra-red spectrum as far as the thermoscopic methods and further than the chemical reactions.

No. 10, September 8, 1884.

Researches on the General Progress of Vegetation in an Annual Plant. Nitrogenous Principles and Mineral Matter.—MM. Berthelot and André.—The albumenoid principles are stationary at the moment of germination, and increase afterwards rapidly so as to attain a thousand times their original weight. Their pro-

portion to the total weight of the plant does not vary much (14 to 21 per cent) up to the epoch of flowering. It then declines, and at the moment of fructification and at the death of the plant is reduced to about 5 per cent. This depends partly on the destruction of the nitrogenous compounds and partly on the preponderant formation of lignine. In the plant deprived of its efflorescence the same cause determines a still wider deviation, the albumenoids being reduced to 3 per cent. The relative proportion of the albumenoids varies, therefore, inversely as that of the lignine. The albumenoids are found at first concentrated in the leaves — the seat of the chlorophyllaceous parts and of the work of reduction which fixes carbon and the elements of water. Later, they are transferred into the flowers and the fruit, whilst in the leaves, where the life is decreasing, the relative proportion of nitrogenised matter falls to a fourth of what it has lately been. The same diminution takes place in the stem and in the roots, by reason of the increase of the hydrocarbons. The salts of potassium increase in absolute weight until fructification, this increase being chiefly seated in the stem. Their relative proportion reaches its maximum in the stem and the roots at the moment of inflorescence. Subsequently, they are distributed more equally. The insoluble mineral bitters accumulate in the leaves and in the flowers.

No. 11, September 15, 1884.

This number contains no chemical matter.

Journal für Praktische Chemie.
New Series, Vol. xxx., Part 1 and
(Nos. 12 and 13 for 1884).

A Contribution to the Chemistry of the Chrome Ammoniacal Compounds.—S. M. Jörgensen.—In this paper the author examines at considerable length the luteo-chrome salts, describing the luteo-chrome nitrate, luteo-chrome-nitrate - platinum - chloride, luteo - chrome-platinum-chloride, the corresponding mercuric compound; luteo-chrome-bromide, luteo-chrome - platinum - bromide, the corresponding iodide and iodo-sulphate, luteo-chrome sulphate, luteo-chrome-sulphate-platinum-chloride, luteo-chrome orthophosphate, oxalate, luteo chrome sodium pyrophosphate, luteo-chrome ferricyanide, luteo-chrome cobalticyanide, and luteo-chrome-chromicyanide.

Communications from the Agricultural-Chemical Laboratory of the University of Königsberg.—These communications consist of a paper on betaine obtained from cotton-seed cake, by H. Ritthausen and F. Weger.

On Mercury Fulminate.—Alex. Ehrenberg.—Aqueous hydrochloric acid decomposes mercury fulminate, forming hydroxylamine hydrochlorate, and formic acid, both atoms of nitrogen being transmitted into the hydroxyl-amine. This reaction argues against the conception of fulminic acid as nitro-aceto-nitrile. Aqueous hydrosulphocyanic acid decomposes mercury fulminate, with formation of ammonium sulphocyanide and carbonic acid. Free fulminic acid does not seem capable of existing, since the product dissolved in ether undergoes spontaneous decomposition even in a vacuum after the evaporation of the solvent. Ammonium sulphocyanide acts upon mercury fulminate in the same manner as the alkaline chlorides, forming a fulminurate.

Distribution of the Blood-Pigment between Carbon Monoxide and Oxygen: a Contribution to the Theory of Chemical Mass-Action.—G. Hüfner.—This memoir is not suitable for abstraction.

On Isatine.—H. Kolbe.—In this preliminary communication the author mentions an isatoic acid which he obtains by treating isatine with chromic acid in presence of glacial acetic acid or acetic anhydride. Its composition is $C_8H_5NO_3$. It is sparingly soluble in cold water and alcohol, more readily in the same liquids when hot. From hot water it crystallises in long needles, and from boiling alcohol in yellow rhombic tables. It is a feeble acid, and forms salts with the alkalies. Isatoic acid may also be obtained from pure indigo-blue by treatment with chromic acid and glacial acetic acid.

On Certain Derivatives of Mercury Fulminate.—L. Scholvien.—A preliminary communication in which the author studies the action of sulphuric acid upon sodium fulminate, silver fulminate (whereby he shows that the compound obtained by precipitating sodium fulminate with silver nitrate is in all respects identical with that obtained from metallic silver), and the action of sulphurea upon mercury fulminate. The products of this reaction are carbonic acid, mercury sulphide, urea, and sulphurea-mercury sulpho-cyanide.

Electric Conductivity of the Acids.—W. Ostwald.—The author suggests that in reactions which take place under the influence of acids the rapidities of such reactions are proportional to the electric conductivity of the acids. He states that Svante Arrhenius had earlier, though unknown to him, arrived at essentially the same result.

MISCELLANEOUS.

Appointment.—Dr. A. B. Griffiths, F.C.S., &c., Lecturer on Metallurgy at the City of London College, has been appointed to the Chair of Chemistry and Metallurgy and Director of Laboratories at the Technical College, Manchester.

Metallurgical Lectures at the Royal School of Mines.—The course of lectures will begin early in November, as soon as Prof. Chandler Roberts returns from his visit to the Metallurgical districts of Colorado and Denver. He is also to examine the various Mints and Assay Offices of the United States. The Metallurgical Laboratory, to which a powerful testing machine has been added, opens in the first week of October.

Modern Mummies.—A Paper by Mr. Thomas Bayley, Consulting Chemist, of Birmingham, was among those communicated to the recent Social Science Congress. The author of the Paper points out that cremation immediately subsequent to burial, as at present advocated, would undoubtedly place facilities in the way of poisoners and other criminals. He proposes therefore to keep the body for a certain time after death, and treat it in such a manner as to avoid putrefaction. The bodies according to this method would be loosely but completely enveloped in cotton-wool, within air-tight cases of open construction which would be rivetted up. They would then be exposed in underground galleries lined with impervious cement to a current of cold and dry air, from which the germs capable of exciting putrefaction would be removed by filtration. The cooling would be effected by machinery working on the compressed air principle, and the air traversing the chambers would be dried by chemical agents, of which there are several suitable. At first thorough cooling would be necessary, but after a time the drying could be effected more rapidly at a higher temperature. The process would result in the formation of mummies with white integument similar to those produced by the most efficient and costly system of embalming in ancient Egypt. Attached to each dehydratorium, which is the name proposed for the building where the new process would be conducted, there might be established cool mortuary chambers for bodies awaiting inquest. After treatment the bodies might be cremated, or kept for an indefinite period in a dry place or in air-tight cases. It is certain that had this process been applied to the bodies now lying in Westminster Abbey, the authorities would not have had reason, as at present, to refuse further admissions on sanitary grounds.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bones.—(Reply to L. Hundeshagen.)—Bone manure was made at Aston, near Birmingham, on a small scale some years since by steeping bones in dilute muriatic acid, with excellent results, the fertility of the soil being greatly increased by this manure.—G. A. KEYWORTH.

TO CORRESPONDENTS.

C. H. M. Mann.—In addition to Roscoe's "Organic Chemistry," you should consult Fownes's Chemistry, edited by Watts, and Miller's Chemistry, edited by Groves and Armstrong. There is also a very good elementary work by Armstrong in Longman's scientific series.

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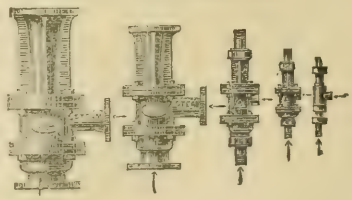

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THE CHEMICAL NEWS.

Vol. L. No. 1298.

A MEMOIR DETAILING SOME MINOR RESEARCHES ON THE ACTION OF FERROUS SULPHATE ON PLANT-LIFE.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, Silver and Bronze Medallist in Chemistry and Botany.

As my investigations on the use of ferrous sulphate as a manure for certain crops are well known to chemists, this paper (which was the substance of a memoir of mine read before the Chemical Society on the 15th of May last, but contains additional notes, &c.), does not require to be supplemented by very many remarks concerning my former resesrches on this subject. I have already shown that ferrous sulphate is an excellent food for certain plants, particularly those developing a large amount of chlorophyll. My subsequent experiments prove that an *excess* of iron sulphate is fatal to plant-life. In fact it appears to be an analogous case to carbonic anhydride as a food for plants, for MM. Déhérain and Maquenne (*Biedermann's Centralblatt f. Agricultur-chemie*, vol., xi., part 7; and *Annales Agronomiques*, 7, p. 385 to 406), have shown that vegetation derives a decided advantage in atmospheres rich in carbonic anhydride, and Dr. T. L. Phipson F.C.S., kindly informs me that in 1855, when at Brussels University, he first observed that an excess of this gas acts as a poison to plant-life: and this has since been confirmed by other chemists. Here I wish to detail some experiments I have made on plants growing in solutions containing varying amounts of ferrous sulphate.

I made up culture solutions containing the following ingredients:—

Water	100·00	grammes.
Potassium nitrate	0·10	,,
Sodium chloride	0·05	,,
Calcium carbonate	0·05	,,
Magnesium carbonate	0·05	,,
Calcium phosphate	0·05	,,
Sodium silicate	0·05	,,
Ferrous sulphate	0·20	,,
	0·15	,,
	0·10	,,
	0·05	,,

Four solutions were made with the above quantities of salts dissolved in 100 grammes of distilled water. The difference between them was in the amount of *ferrous sulphate* in each. No. I. solution contained 0·05 per cent, No. II. 0·1, No. III. 0·15, and No. IV. 0·2 per cent of ferrous sulphate. These solutions were poured into four dishes, and in each dish was placed a piece of flannel, and on each piece of flannel was sown the same number of mustard seeds. These were allowed to germinate and grow until nearly mature, and at stated intervals each set of plants was watered with its proper solution always of the same strength as the original solution. The plants growing in No. III. solution (*i.e.*, the solution containing 0·15 per cent of ferrous sulphate) were the largest and healthiest; and on submitting their ash to analysis the largest amount of ferric oxide was found therein.

The seeds placed in No. IV. solution (*i.e.*, the solution containing 0·2 per cent of ferrous sulphate), never germinated at all; in fact they withered and died. I have since repeated this several times with the same results. This proves that one-fifth per cent of ferrous sulphate proved fatal. The seeds growing in solutions Nos. I. and II. grew well, but *not* so well as No. III., which contained a larger amount of ferrous sulphate in solution. In passing I may say that each set of plants was exposed to the same amount of sunlight, &c. From these experiments it will be seen that solutions containing a gradual increase in the percentage of iron sulphate is beneficial to plant-life *up to a certain point*; beyond this point, the plant declines and dies. In fact, as I stated at the commencement of this paper, it appears to be an analogous case to carbonic anhydride as a food for plants.

Again, when the roots of a young cabbage plant were placed in No. IV. (*i.e.*, the solution containing one-fifth per cent of iron sulphate); the plant in three days showed evidence of decreasing vitality; on taking it out of this solution, drying the roots withing blotting-paper, and then placing them (the roots) in distilled water, the plant began to revive, and in a day or so was healthy again. On analysing the distilled water it was found to contain the excess of ferrous sulphate. From this experiment it appears that the plant growing in the one-fifth per cent solution of the salt of iron would have died (as a similar plant did when left in the solution for a week) if it had not been transferred to the distilled water. When the roots were placed in this new medium there was a "struggle for existence," so to speak, the excess of ferrous sulphate being passed back again into the water, and the plant recovered from the poisonous action of the *excess* of iron.

It will be seen from my previous researches that iron acts as a useful manure, but at the same time if given in excess proves fatal to plant-life, or, in the words of Liebig, "the most nutritious substances may cause death."

These experiments confirm those of Dr. Freytag, of Bonn, that plants are incapable of selecting from the soil the nutritious and rejecting the noxious ingredients. They absorb both indiscriminately; but as the experiments of Macaire-Princep and those of my own (described above) show that plants under certain conditions, and in narrow limits, are capable to a certain extent of excreting matters unnecessary to their existence; and when metallic salts are absorbed in excess, if circumstances, &c., are favourable, the plant returns in the form of an excrement the excess of a noxious salt.

To confirm this poisonous action of excess of ferrous sulphate, I examined, under the higher powers of the microscope, the little water plants *Spirogyra* and *Zygnema*. When these plants were placed in Nos. I., II., and III. solutions respectively, there was no change in colouring matters like eosin or magenta: thus showing that solutions containing 0·05, 0·1, 0·15 per cent of ferrous sulphate respectively, did not kill the little plants; on the contrary, the rotatory movement (*cyclosis*) of the protoplasm (when seen in *Anacharis alsinastrum*) was increased when the plants grew in the solution containing 0·15 per cent of iron sulphate. When the little plants were placed in solution No. IV. containing 0·2 per cent of ferrous sulphate, they died; for I was then capable of staining the protoplasm with eosin or magenta, which proved it was dead. These investigations show that these plants cannot live in a solution containing all the ingredients necessary for plant-life, if that solution contains as much as one-fifth per cent of ferrous sulphate, whereas a smaller amount is most beneficial, rendering the plants healthier and larger than if grown in a medium not containing this iron manure.

THE RELATION BETWEEN THE "WATT" AND "HORSE-POWER."*

By W. H. PREECE, F.R.S.

The most useful practical unit in use among electricians that has been derived from the C.G.S. system of absolute measurement is probably the watt, or the rate of doing work when a current of 1 ampère is maintained through a resistance of 1 ohm. The work done by an electric current

* A Paper read before the Montreal Meeting of the British Association

is thus brought into intimate relation with all other kinds of work. The common gravitation unit rate of working is the horse-power, which is 550 foot-pounds per second. The absolute C.G.S. unit is the erg per second, or the work done in 1 second in overcoming a force of 1 dyne through a distance of 1 centimetre. In any electrical measurement the electric-motive force E in volts multiplied by the current C in ampères gives a product E C equivalent to so many 10^7 ergs per second, which is the watt. There are 746 watts in a horse-power: and hence E C is reduced to horse-power when it is divided by 746. The rate at which electrical energy is developed or expended in any part of any circuit is given in watts when we multiply the number of volts by the number of ampères. Strange mistakes are made in confusing the unit of power with the unit of work. No less an authority than Professor Adams, F.R.S., in his Inaugural Address as President of the Telegraph Engineers and Electricians, spoke of the watt as the unit of work.

The horse-power as a unit has all the defects of an arbitrary unscientific standard. It involves the use of coefficients; and it is not connected directly with the absolute system of measurement. It differs in different parts of the world; and its name is misleading. It could be changed both in value and name without any inconvenience except to those who are familiar with the existing coefficients and formulæ. If its value were raised 34 per cent it would become the kilowatt, and be connected directly with the C.G.S. system. It would thus become scientific, and diminish the use of coefficients. Even the present name could be retained and its value altered from 746 to 1000 watts; or from 33,000 to 44,233 foot-pounds per minute, without any serious inconvenience. Existing numbers expressing horse-power would simply have to be multiplied by 0·746 to bring them to the value of the new unit; or numbers on the new unit would have to be multiplied by 1·34 to express their value int he old system.

I cannot help thinking that the good work of the British Association Committee will not be complete until the C.G.S. system is authoritatively applied to work and power. The following table brings together nearly, if not all, the units in common use:—

Unit	Equivalent.
Horse-power	33,000 foot-pound per minute.
,,	550 foot-pounds per second.
,,	746×10^7 ergs per second.
,,	7460 megergs per second.
,,	75·9 kilogrammetres per second.
,,	1·01385 force de cheval.
,,	746 watts.
Force de cheval	75 kilogrammetres per second.
,,	542·48 foot-pounds.
,,	0·9863 horse-power.
,,	736 watts.
Watt	0·0013405 horse-power.
,,	10^7 ergs.
,,	10 megergs.
,,	$\frac{1}{9{\cdot}81}$ kilogrammetres per second.
,,	0·1029 kilogrammetres per second.
B. of T. unit	1000 watts per hour.
C.G.S. unit	erg per second.
Megerg	10^6 ergs per second.
Watt	10^7 ergs per second.

According to Professor Dewar, a standard sperm candle develops 240,000 foot-pounds per hour, or 4000 foot-pounds per minute. Now, since a watt is equivalent to 44·2 foot-pounds per minute, it follows that a standard candle develops 90 watts per minute. Again, according to the same authority, 5 cubic feet of coal-gas in London develops 2,500,000 foot-pounds per hour, or 41,666 foot-pounds per minute, or 2976 foot-pounds per candle per minute, which is equivalent to 67 watts per minute. A good glow lamp absorbs 2·5 watts per candle per minute. Hence a glow lamp has an economy in energy of about 1-30th of a gas light, and 1-40th of a standard sperm candle. A man working very hard expends about 100 watts per minute; hence, if a man-power is equal to, say, 1 standard candle, it is equal to 1·34 gas candles and to 36 electric candles! What a field for economy in lighting, and how essential it is that gas should be applied to the production of power rather than to the production of light.

PARATOLUIDIN SULPHATE AS A REAGENT FOR NITRIC ACID.

By ANTONIO LONGI.

If to a solution of paratoluidin in sulphuric acid nitric acid is added there appears first a blue colour, which changes into violet, red, and, lastly, into yellowish brown.

Rosenstiehl and Lauth used accordingly nitric acid for detecting paratoluidin in a solution of various aromatic bases in strong sulphuric acid. The author has studied this reaction with reference to the detection of nitric acid, and has obtained very good results.

If to a liquid containing nitrates there are added a few drops of a solution of paratoluidin sulphate, and if an equal volume of sulphuric acid is carefully added, so as to form two strata, there appears immediately, at the line of contact of the two liquids, a red colour, which after a considerable time passes into a dark yellow. If paratoluidin sulphate acts in a similar manner upon chlorates, bromates, iodates, chromates, or permanganates, there is formed instead of the red an intense blue colour, so strong that it completely masks the reaction of the nitrates if only a small quantity of one of the above-named salts is present.

The solution of aniline sulphate, if similarly used, gives no colour; but if a mixture of the salts of both bases is used, the reaction is more sensitive, and the red colour more intense. A solution of aniline oil in dilute sulphuric acid may therefore be advantageously used as a reagent instead of pure paratoluidin sulphate.

In order to ascertain the limits of the sensitiveness of this reaction the author has tried it with solutions containing different proportions of potassium nitrate. He succeeded in detecting the nitric acid in a liquid containing 1-32,000th.

By means of chrysaniline, as proposed by W. Hofmann, scarcely 1-1000th part can be detected. Ferrous sulphate is differently sensitive according to the manner in which it is used. If a strong solution of this salt is poured upon a cold mixture of 1 vol. of the liquid containing nitric acid and 1 vol. strong sulphuric acid, 1-2000th nitric acid may be detected. But if to the solution containing a nitrate there is added an equal volume of strong sulphuric acid so that the liquids do not mix, and if a few small crystals of good ferrous sulphate are dropped in, 1-8000th part of nitric acid may be detected.

By means of indigo 1-64,000th may be detected, and by means of the reaction with caustic potassa and zinc-powder, proposed by P. Tassinari and P. Piazza, 1-160,539th of nitric acid may be recognised.

Brucine has hitherto been regarded as the most sensitive reagent for nitric acid. Kersting, who used it in an aqueous solution (1 : 1000), succeeded in discovering 1-100,000th nitric acid. But if into a solution containing nitric acid there is poured sulphuric acid in which a small quantity of brucine has been dissolved, we obtain the well-known colouration even with liquids containing 1-256,000th nitric acid.

The sensitiveness of brucine is considerably surpassed by that of diphenylamin. It forms with nitric or nitrous acid dissolved in strong sulphuric or nitric acid, an oxidation-product of so intense a blue that even the minutest traces suffice to give a distinct colouration. E. Kopp

used this reaction for the detection of nitric and nitrous acids in commercial sulphuric acid, and asserts that it is at least as sensitive as that with ferrous sulphate. The author has examined whether diphenylamin can be used for the detection of nitric acid in aqueous solutions.

If the liquid containing nitric acid is mixed with a few drops of diphenylamin sulphate and a layer of strong sulphuric acid is then added, there is formed a very fine blue colouration which persists for a considerable time. By operating in the manner just described solutions of nitric acid containing 1-1,500,000th always give a distinct colouration. The reaction only begins to be doubtful with solutions containing 1-2,000,000th.

Though paratoluidin is not so sensitive as brucine and diphenylamin, it is nevertheless preferable because it does nor give the reaction with chloric, chromic, and iodic acids, nor even with nitrous acid.

If a solution of paratoluidin sulphate is added to a liquid containing nitrous acid and then sulphuric acid as above, we obtain a yellowish brown colour if the solutions are strong, and if they are dilute, a yellow, which after a time turns to a red, as a part of the free nitrous acid is converted into nitric acid. The reagent may therefore serve to distinguish nitrates from nitrites. For this purpose the solution in question is diluted rather copiously, and it is noticed whether the reagent immediately gives the red colour which is characteristic of nitric acid. If it is required to detect nitric acid in presence of much nitrous acid the reaction is applicable, since the yellowish brown colouration of the latter completely masks the red of the nitric acid. In such cases, as Piccini proposed, the nitrous acid may be decomposed by means of urea. The author applies Piccini's method in a somewhat modified form. To the solution containing a nitrite he adds an excess of urea, and then, by degrees, acetic acid, until gas is no longer evolved in the cold. He then evaporates on the water-bath and tests the solution of the residue for nitric acid.—*Zeitschrift f. Analyt. Chemie.*

ALLOYS USED FOR COINAGE.*

By W. CHANDLER ROBERTS, F.R.S.

(Concluded from p. 162).

We have now to consider the means adopted to secure accuracy in the weight of coins issued from the Mint, and to examine the questions connected with the loss in weight sustained by coins during their circulation. Before the invention of coined money, the precious metals circulated by weight. Examples of such currency are presented by the gold and silver "talents" of the Schliemann collection, which bear a definite relation to the Babylonian "mina;" and so completely has the spirit of this method of circulation by weight been retained, that the best definition we possess of coins represents them as "ingots, of which the weight and fineness are certified by the integrity of the designs impressed upon the surfaces of the metal."†

Rice Vaughan,‡ whom I have before quoted, has some interesting remarks on this point in the section of his little work devoted to the consideration "of coining moneys without distinction of weights." He says the proposition is, "that there should be coined no pieces of a certain [*i.e.* definite] weight, either of gold or silver, but that, the allay being certain, the weight should remain uncertain; all money now currant should be valued by a certain weight." For example, every ounce of silver should be valued at five shillings and every ounce of gold at such a proportion as shall be thought most equal. He points out that, among other incidental advantages, this plan would prevent the "culling, washing, and clipping," of money, that is, its fraudulent reduction in weight; but on the other hand, the objection would be, as he says, "the extreme molestation which the people should receive in the practice of it, when every man should be bound to carry scales in his pocket, and upon every little payment be bound to weigh their money." Few people at the present day bear in mind that this is precisely what, in the case of the gold coin, the existing law requires them to do, for the Coinage Act of 1870, now in force, directs, in Section 7, that "where any gold coin of the realm is below the current weight provided by this Act, every person shall, by himself or others, cut, break, or deface such coin tendered to him in payment, and the person tendering the same shall bear the loss." Compliance with this demand would, of course, render it necessary for each individual, who has reason to expect the tender of a sovereign, to carry scales and weights, as well as shears to cut such pieces as should be found to be deficient in weight.

It will be well for us to examine—1st, what degree of accuracy as to weight the law requires in pieces issued by the Mint; and 2nd, how long gold coins may be expected to circulate without incurring the "extreme penalty of the law," which takes the same view of coins as is expressed in Butler's "Erewhon" with regard to humanity, and considers defective organisation and decrepitude in a coin to be criminal, and punishable by "cutting and defacing." Mr. John Biddulph Martin, whom I shall again have occasion to quote, well observes, "We are wont to speak of the life of a coin, but whereas the term 'life' is in all other cases associated with a period of growth, of maturity, and of decay, in this instance the process is one of degradation only."

The first schedule of the Coinage Act of 1870 prescribes the weight at which each coin shall be issued; it also defines the lowest weight at which the gold coins may be permitted to circulate, and it sets forth the "remedy" of weight—that is, the range above or below the exact standard within which the issue of coins would be legal. The silver and bronze coins, being merely tokens, have no "least current weight," but are withdrawn from circulation, and re-coined, when they become defaced by wea. The standard weight of a sovereign is 123·27447 grains, the remedy is $\pm$ 0·2 of a grain, and the least current weight 122·5 grains. In the case of the half-sovereign, the standard weight is 61·63723 grains, the "remedy" $\pm$ 0·1, and the least current weight 61·125 grains. In order to ensure that the coins issued from the Mint shall be well within the remedy allowed by law, it is necessary to adopt in practice a still more minute margin, or allowance for unavoidable error. The "working remedy" adopted in the Mint in the case of the sovereign is therefore fixed at 0·17 of a grain, instead of the 0·20 which the law allows, and the weight which denotes whether a sovereign is or is not within the remedy is represented by a piece of wire of fine gold, 0·1355 inch in length, and 0·018 inch in diameter, and weighing 0·17 of a grain. It will be obvious that the possibility of restricting the weight of coin within such narrow limits entirely depends on the degree of accuracy which may be attained by the process of rolling the strips of metal from which the discs destined to form the finished coin are cut; and we have already seen, in the first lecture, that in the case of the fillet prepared for the manufacture of the half-sovereign, a variation of $\frac{1}{20\,000}$th of an inch above or below the accurate thickness, or a range of $\frac{1}{10\,000}$th of an inch in the the thickness of the fillet, would cause the rejection of the coin, on the ground of excess or deficiency of weight. The question then arises—Is it not possible to supplement the operation of rolling by some mechanical operation, conducted on the blanks themselves, in order to bring them within a closer approximation to the exact weight. The problem has long proved an attractive one in Mints, but the earliest suggestion I can find for securing absolute accuracy in weight occurs in the "Records of the Scotch Mint,* from

* Cantor Lectures delivered before the Society of Arts.
† Stanley Jevons, "Money," p. 57. 1876.
‡ "A Discourse of Coin and Coinage," p. 214. 1675.

* "Records of the Coinage of Scotland," by R. W. Cochran-Patrick, Esq., M.P. 1876. Introduction, p. cix.

which it appears that J. Acheson claimed, in 1597, to have discovered a method of making coins so that none shall be "ane grane heavier or lichter nor another."

On the Continent it is very generally the practice to adjust blanks by the aid of a file, the weighing being performed by hand; the process is, however, open to the objection that the marks of the file are never quite obliterated when the blanks are struck into coin, and the same objection applies to most of the machines that remove a fine shaving of metal from the surface of the blank. An additional objection to such a mechanical adjustment of blanks arises from the tendency, in Mints where it is adopted, to produce "too heavy" blanks in the rolling and cutting departments, as it is impossible to adjust blanks which are too light. Some years ago, Mr. J. M. Napier* devised for the Indian Mints an automatic machine of great beauty, which first ascertains how much it is necessary to cut from each blank in order to reduce it to the standard weight, and then removes the necessary amount of metal and no more. The initial cost of such machinery is, however, considerable. Another machine, having the same object in view, has been devised by M. Seyss.†

Chemical aid has not been wanting in the attempt to solve the question of the adjustment of blanks. In 1849, M. Diereck, Director of the Mint in Paris, endeavoured to substitute a chemical for a mechanical treatment by submitting the heavy gold blanks to *aqua regia*, which, it was anticipated, would bring them within the prescribed limits of accuracy, by dissolving away metal. The results were not satisfactory, and the attempt was abandoned.

Having myself attacked the question in 1870, I may, perhaps, be permitted to refer to the results which attended my experiments. It was found that gold, alloyed with copper, might be removed from heavy blanks with singular regularity by means of a suitable solvent aided by a battery. The blanks were arranged in a frame of wood, and submitted to the action of a solution of cyanide of potassium, the heavy blanks forming the dissolving pole of the battery. The process was not used in the London Mint, as it became evident that it could not replace the present system, under which finished coins alone are weighed, and the manufacture of good coin only is paid for. The late M de Jacobi, one of the earliest workers in the field of electro-metallurgy, visited my laboratory while the first experiments were in progress, and we discussed the possibility of re-depositing the metal removed from the heavy blanks on those that were too light, the problem being to obtain a tenacious film.

I was greatly interested to find, long after my experiments were made, that an eminent firm of electrotypers had suggested officially that the worn gold coins in circulation could be restored to the legal weight by the electric deposition of a film of gold on the surfaces. The process was introduced into the Bombay Mint, in 1873, by the late Mr. L. G. Hines, who transferred the metal dissolved from the heavy blanks to blanks which are too light, the latter being by this means raised to the prescribed weight. Its importance in mints where its use is possible may be gathered from the fact that, in the Indian mints, no less than 1300 tons of silver were converted into coin in one year (1879), so that the saving effected by its use must be considerable.

Whether or not a method for adjusting the blanks be adopted, the finished coin must be weighed before it leaves the Mint, and this, as before stated, is the great obstacle to the introduction of the electro-chemical method into the English Mint. In former times the weighing was effected only in bulk, but more recently individual pieces have been weighed in this country. I have already pointed out that the weighing may be effected by hand, and this method is very generally adopted on the Continent and in America, where each operator is provided with a delicate pair of scales.

In the Mint of this country, very beautiful automatic machines are used, for a full description of which reference may be made to the "Encyclopædia Britannica."* [Note.—The general nature of the appliance was made clear by the aid of a model.] The balance was originally devised in 1851 by the late Mr. William Cotton, of the Bank of England, and has since been improved by the officers of the Mint, and by Mr. J. M. Napier, who has secured several patents in connection with this machine.

In the Vienna Mint, a balance devised by Herr Seyss is employed, which depends upon a somewhat different principle. The beam resembles that of an ordinary balance, with pans suspended from it; one pan contains the weight, and a slide brings forward the coin to the other pan; the depression of the beam produced by a heavy coin brings the balance pan opposite one of several slits, the lowest slit corresponding with the extreme depression of the beam produced by a very heavy coin. The pan is then momentarily fixed, and the coin is allowed to pass away into the slit against which it stands. If coin is very light, the pan which contains it will rise and stand opposite the highest of the series of slits.

The life of a coin, after it leaves the Mint, may now be traced, and it will be seen that the conditions of its existence are far less severe in modern than they were in ancient times. The actual wear to which coins are subjected may, no doubt, be rougher at the present day than in the past; but, on the other hand, they are not subject, to anything like the same extent, to ill-treatment from enemies in the shape of clippers and sweaters.

It is difficult to over-rate the importance of some system of protecting the edge of the coin against fraudulent treatment, and it is hardly less difficult to understand, at the present day, the extent to which the ill-shapen hammered coins were tampered with. The earliest protection seems to have been afforded by a circle or beaded ring on the surfaces of the coin, and that such circles have been used from early times is proved by the fact that many Greek coins bear them. Attention is specially directed to the outer circle in an enactment of King Henry VII., which provides that "every piece is to have a circle about the utter part thereof, and also that all manner of gold hereafter to be coined shall have the whole sculpture without lacking any part thereof, to the intent that the King's subjects might have perfect knowledge, by that circle or sculpture, when the coins were clipped or not." No protection, however, is as efficient as the addition of letterings or devices round the edge of the coins. I have already stated in the first lecture that the practice of marking the edges was adopted, for another reason, in Roman times in the case of the *Nummi Serrati*, mentioned by Tacitus.

Coins may be fraudulently reduced in weight by the action of a solvent aided by a battery, but there is reason to believe that the practice is only carried on to a very limited extent.

Removal of metal by drilling holes and filling them up by base metal has sometimes been resorted to, and the Mint Museum contains interesting examples of American coins which have been sawn so as to leave two thin flat discs, which have subsequently been soldered over a disc of base metal, the precious inside of the coin having been removed. It has been proposed to make the American gold double-eagle dish-shaped, in order to render the centre so thin as to prevent this method of falsification. In mediæval times, tampering with the coin caused the gravest anxiety, and was punished with dreadful severity.

In 1381, the first equivalent of the modern Royal Commission on the Coinage met, and the following was the evidence, or rather were the recommendations, of the individuals who took part in it. Richard Leyc advised that the practice of clipping the gold coin could only be checked by a proclamation directing individuals to weigh coins

* Patent, No. 103. 1860.

† *Dingler's Polytechnisches Journal*, ccxlv., 61; plate 6. 1882.

* Ninth edition, art. "Mint."

when they took them, and Richard Aylesbury, a goldsmith, also held that gold pieces which had been reduced by clipping should be universally weighed by those who received them.* I will take only a few more historical instances of instructions as to weighing the coins tendered to individuals. The Mint Records† contain a copy of a proclamation given in the 17th year of King James I., which states that the people, instead of refusing such light gold moneys as were without the remedies * * * * do now for the most part accept in payments, indifferently and promiscuously, all such coins whatsoever tendered unto them, without weighing," which shows that the practice of weighing the coin had been adopted, and was falling into disuse. In 1619, the person who tendered the gold coin was instructed to give twopence for every grain the coin was light, and individuals were directed to brand every piece abnormally light by striking a hole through it, returning such pieces to the owners thereof, thus re-affirming a proclamation made in 1587 by Queen Elizabeth, which directed that the defective coins should be "stricken through and cut into pieces." In 1632, it is stated that "in and about London and Westminster, people carried scales in their pockets, to weigh gold on all occasions."‡ I mention these facts to show that the directions of the present law (Coinage Act, 1870) as to the cutting and defacing of worn coin rest on ancient precept.

The condition of the silver currency in the end of the 17th century may be gathered from the statement of Lowndes, who computed the amount of all the silver moneys coined in the reigns of Queen Elizabeth, James I., and Charles I., at £15,109,476. Writing in 1695, and allowing for the sums coined in the reign of Charles II., James II., and William and Mary, he did not consider that the silver circulation consisted of more than £5,600,000, of which only £1,600,000 was heavy ;‖ and he further pointed out, as the result of careful weighing of the coin in bulk, that the weight of "the moneys commonly currant are diminished near one-half." Not, it must be remembered, merely by legitimate wear, but by the fraudulent practice of "clipping," from which, I believe, modern coinages suffer to a hardly appreciable extent.

It is now necessary to consider the conditions affecting the circulation of a metallic currency, more especially as regards its power of resisting legitimate wear. An experimental inquiry conducted by the officers of the Mint towards the close of the last century, showed that $78\frac{1}{2}\%$ of the shillings then in circulation were required to make a pound weight, which should have been represented by 62 shillings; eleven years later, $82\frac{9}{40}\%$ shillings weighed a pound. With regard to the gold coinage, the Mint officers found, in 1807, that 1,000 guineas withdrawn from circulation had lost 19s. per cent in value. Parcels of 300 sovereigns, coined in each of the years 1817-21-25-29, were weighed by the officers of the Mint in 1853, and the results proved that they had sustained an average rate of wear of 0·047 grain per annum.

The rate of wear, in the case of gold coins, is dealt with by Jacob;§ but we owe an authoritative determination of the annual rate of wear of the gold coin to the late Professor W. Stanley Jevons, F.R.S.¶—formerly assayer of the Sydney branch of the Royal Mint, and subsequently Professor of Political Economy at University College, London—who brought to the consideration of the question an acute intellect and perfect knowledge of the conditions which govern the metallic currency. He proved, as the result of an exhaustive enquiry, that "just about eighteen years' wear will reduce a sovereign below its point of legal currency"; and he shows conclusively that the average rate of wear per annum of the sovereign is 0·043 grain, which led to the conclusion that, at the time he wrote, 1868, "31·5 per cent of the whole of the sovereigns in the kingdom are now no longer of legal currency." He estimated the annual average wear of the half-sovereign at 0·069 grain. Mr. Martin* has since repeated and extended Professor Jevons's inquiry. He has greatly added to the value of the work by bringing it down to the present time; and his researches, which deal with no less than 105,364 sovereigns, confirm, in a remarkable manner, the average rate of wear deduced by Professor Jevons, who adopted a different method of calculation. It may safely be assumed, therefore, that any sovereign which has been in circulation more than eighteen years has been reduced to a point at which it is not legally current, and should, therefore, be withdrawn from circulation, in order that it may be re-coined.

The questions now present themselves—Can this average rate of wear be diminished? Is the form of the coin well adapted to enable it to resist wear; and is it possible to adopt a more durable alloy for our gold coinage? First, with regard to the form; no doubt a sphere which contains the maximum weight in the smallest surface is better adapted than a disc to resist the abrading influence of friction, and it follows, therefore, that the Siamese money, which is nearly globular, will retain its weight longer than any other coin now in circulation.

A short cylinder is the geometrical form which, next to the sphere, presents the smallest surface for the greatest weight, and, consequently, in order to reduce the wear of coins to a minimum, their thickness should be equal to their diameter. Such a form would present many inconveniences; but, on the other hand, coins should not be made too thin, and much may be gained by even a small approach to theoretical requirements. A good practical rule for calculating the most useful diameter of a coin from its weight is given by the following formulæ:—

$$D = P \sqrt[3]{G}$$

D = Diameter in millimetres.
G = Weight in grammes.
P = A certain number found by experiment.

Take the cube root of the weight of the coin, multiply by the number for the particular coin, and this gives the most suitable diameter in millimetres. The value of P for all kinds of gold coins is 11·3. †

I have thought it advisable to make the above reference to the matter, although it is not likely that the form of our coins will ever be greatly modified. The mean thickness of the coin does not differ much from the initial thickness of the blank, because in virtue of the "flow" of metals, to which allusion has already been made, the portions of metal diminished in thickness are about balanced by the raised part of the device. Sharp new coins do not wear much more rapidly than old ones, as is shown by the experiments of Professor Jevons and Mr. Martin; that is, the rate of wear of coins at different periods of their career is fairly normal. There is no doubt that a coin in high relief becomes disfigured much sooner than one in low relief, as the unity of a design is greatly impaired by the loss of a prominent feature, and the lovely Renaissance works in low relief [now before you] present a much better appearance after prolonged circulation than their classical predecessors, which are almost lenticular in form. The power of the metal to resist, not wear, but deformation by impact, therefore demands attention, and from this point of view a soft metal is far less useful than a hard one. Coins of lead, for instance, have been found, in experiments to which reference will be made presently, to become rapidly defaced, and reduced to the state of mere blanks, when submitted to mutual action in a re-

* Ruding, vol. i., p. 240.
† "Record Book," vol. i., p. 56.
‡ Ruding, vol. i., p. 386.
‖ "Essay for Amendment of the Silver Coins," p. 105. 1695.
§ "The Precious Metals," vol. ii., p. 168. 1831.
¶ *Journal of the Statistical Society*. 1868.

* *Journal of the Institute of Bankers*, June, 1882.
† Karmarsch, "Handbuch der Mechanischen Tichnologie," vol. i., p. 551. Hanover. 1876.

volving drum. Coins of pure gold also become rapidly defaced, although their weight is but little reduced by such treatment. As has already been pointed out, the reason for using an alloy instead of pure metal is the greater durability of the former, and accurate experiments on this point have not been wanting. Their history may be briefly stated as follows:—In 1792, the unfortunate French Statesman Clavière* proposed that pure metals should be used for coinage, and that they should be current by weight. The Académie des Sciences was consulted on the subject, and experiments made by this distinguished body† showed that while the pure metals were rapidly reduced in weight by friction, the addition of even a small amount of base metal had a notable effect in enabling the metals to resist abrasion by wear. In 1798, the Privy Council appointed a commirtee "to take into consideration the state of the coins of this realm," and they directed Mr. Henry Cavendish, F.R.S., and Mr. Charles Hatchett, to ascertain experimentally whether the loss of gold coins by wear was "occasioned by any defect, either in the quality of the standard gold, or the figure or impression of the coins.' The result was an elaborate investigation, conducted by Mr. Hatchett,‡ on the "comparative wear of gold," the results of which have since been frequently quoted, and have, in fact, become classical. Hatchett operated both on unstamped blanks, and on discs struck by dies, which produced small "rounded prominences, regularly disposed over the surface of the coin." Such blanks, or coined discs, were arranged in two frames, so that the flat surfaces of the metal could rub against each other when the frames were pressed together. Each frame was moved rapidly backwards and forwards by suitable mechanism, the path of each frame being at right angles to the other. The discs were in this way subjected to mutual friction, and the gearing was so devised that while one frame was moving with its greatest velocity, the other was at the extremity of its path, the result being that the coins were prevented from moving always in the same line. The numbers of "revolutions" or contacts of the pieces varied from 20,680 to 229,000. He also used a cubical box of eight inches, in the side, in which the coins were made to revolve; and the discs were also rubbed on a table covered with either flour, fine chalk, or metallic filings, fixed in isinglass. Hatchett's main conclusion was that the "extraordinary loss which the gold coin of the kingdom is stated to have sustained within a certain limited time, cannot, with even a shadow of probability, be attributed to any important defect in the composition or quality of the standard gold."‖ He further observes "that the experiments on the various alloys of standard gold (that is gold standardised with various metals) concur with established practice and opinion to prove that only two of the metals, viz., silver and copper, are proper to be employed in the reduction of fine gold to standard for the purpose of coin." Notwithstanding the care and skill employed by Hatchett in conducting his experiments, some of his deductions appear to demand confirmation. The subject possesses additional interest at the present time, because it is probable that much of the light gold coin now in circulation will soon be withdrawn; and it has therefore been considered advisable that Mr. R. A. Hill, Superintendent of the Operative Department, and myself should resume an investigation on the relative wear of coins of different metals and alloys, which was begun by one of us during the Mastership of the late Mr. Graham. After several preliminary experiments, in which a sliding motion was given to pieces of metal along a smooth surface of oak, we satisfied ourselves that revolving the pieces in a box represents more faithfully the kind of friction to which coins are subjected in the varying conditions of their circulation, and this view was fortified by the opinion of the late Professor Jevons. We addressed ourselves mainly to ascertaining whether the alloy used for the British gold coin, the standard of which is 916·6, is, or is not, more durable than the alloy of 900 fine, which is so widely used by other nations; and we are satisfied that the experimental evidence proves, as regards rate of wear, that there is not much to choose between standards 916·6 and 900. On the other hand, differences in mechanical treatment, resulting from a heavy as compared with a light blow, or in thermal changes produced by annealing, exert greater influence on the rate of wear than the small variation in composition comprised between the limits 900 and 916·6. We agree with the view taken by M. Feer-Herzog* that differences of wear of coins of these two alloys is very slight.

Our experiments are in progress, but the results hitherto obtained are published in the Mint Report for last year.†

The use of aluminium has often been suggested for the manufacture of subsidiary coins, this metal being known to possess the great tenacity when equal volumes of it and other metals are compared. We have been much interested to observe that coins of aluminium, especially if they be alloyed with about 2 per cent of nickel, are very durable, as are also coins of pure nickel; but in one case the durability results from toughness, and in the other from hardness.

There is one other point in connection with the gold currency to which I would now direct your attention. The Coinage Act of 1870 fixes the remedy on each individual piece, and not, as was the case formerly, on the pound weight of the coin. The object of this provision is to prevent the "culling" the heavy pieces, which would be a profitable transaction if the inequalities of weight were considerable. The heavy pieces so selected might either be exported or used in the arts, and the annals of the coinage abundantly indicate the extent to which the practice was carried on in former times. A notable case occurred in 1637,‡ when the Attorney-General charged several persons before the Star Chamber with "culling out the weightiest coins, and with melting down his Majesty's moneys into bullion;" and, on examination, it appeared "that between the years 1626-1631, one Timothy Eman culled £500,000 a-year, which yielded £7000 or £8000 of heavy moneys yearly, and in five years he melted down £15,000, his profit therout amounting to £100." Another offender was Violet, whose name deserves mention, as his work "An Appeal to Cæsar" contains so much curious information as to the export of bullion.‖

I regret to say that the practice of culling is not absolutely unknown at the present day. Prof. Jevons stated, in 1868, that he "received overwhelming evidence that this picking and culling of the coinage, as it used to be called, is practised as an ordinary business transaction by all banks which need to make remittances to the Bank of England," in order, that is, to avoid the loss which would be entailed if light coin were sent to the Bank, where it would be cut and the deficiency charged for. "It will thus be apparent," Prof. Jevons adds, "that there exists a regular system, whereby the older coins are continually returned into the hands of the public, and the new heavy coins alone are returned to the Bank of England, or to those who would melt or export them."

The amount of gold actually in circulation is estimated to be £100,000,000, but the coinage returns show that the amount of sovereigns and half-sovereigns issued since 1816, when their coinage was begun, is £247,521,429. What, then, has become of the 147 millions not in circulation? The coinage returns show that between the years 1864-83 £57,492,842 in sovereigns were coined. A considerable proportion of these have been exported never to return. The following figures, which I offer with some hesitation as they may not be rigidly accurate, show that, while during the same period sovereigns were exported

* "Traité des Monnaies," par. P. F. Bonneville, p. xxiii. 1806.
† *Annales de Chimie*, (1793), tome xvi., p. 230.
‡ *Phil. Trans. Roy. Soc.*, 1803, p. 43.
‖ *Loc. cit.*, p. 190.

* See "Enquête sur la question Monétaire" (Paris, 1792), vol. i., p. 344.
† "Fourteenth Report of the Mint," p. 45, 1883.
‡ "Ruding," vol. i., p. 389.
‖ "An Appeal to Cæsar," by Thomas Violet, of London. 1660.

and imported, the excess of exports over imports was no less than £25,991,445, or a yearly average of £1,299,572.

With regard to the disappearance of gold coins from circulation, Prof. Jevons has some observations of extraordinary interest. He says it appears "that of the sovereigns coined in 1817-19, not more than one-fiftieth part remain in circulation; and the proportion rises until, between the years 1840-1858, it is about one-third." He suggests in his paper that these curves should be plotted graphically. In both cases there is an elevation in the period 1840-45, arising probably from the re-coinage of the years 1841-43, when £14,000,000 of gold coin were called in and re-distributed in an unusual manner, so that more than a common proportion became fixed in the circulation. The most important peculiarity of the numbers is the very small increase which takes place in the proportion of sovereigns preserved between the years 1832 and 1854: this indicates that there is a residuum of coin which is no longer subject to be exported or withdrawn, like the rest of the circulation; for if the proportions of coins exported were taken indifferently, the curve would rise as rapidly as is the case with the half-sovereign curve, those coins not being liable to exportation.

It will be evident, therefore, that in tracing the analogy between the life of a coin and ordinary vital phenomena, we are abruptly checked by observing that the "fittest" coins are not those which survive as the fittest; that is, the heavy ones drop out of the struggle of active circulation they were created to sustain, and are either exported or exist as part of a "hoard" of coin. It may, of course, be urged on this ground that a full-weight coin, issued to the public without charge, is not the fittest to retain its place in circulation, and that a small amount of metal lost by wear really tends to its preservation.

With that Darwinian problem I must bring these lectures to a close.* You have seen the great change and depreciations through which the "alloys used for coinage" have passed in times gone by, but there is no probability that in this country similar changes will take place in the future, and I cannot find better words to offer you than a quotation from Professor Jevons, whose perfect grasp of the question of metallic currency enabled him to realise its difficulties in a way few of us are able to do. He points out that, in times past, the rulers of nations have been the most notorious false coiners and depreciators of the currency; but that now "the danger lies quite in the opposite direction—that popular governments will not venture upon the most obvious and necessary improvement of the monetary system without obtaining a concurrence of popular opinion in its favour; while the people, influenced by habit, and with little knowledge of the subject, will never be able to agree upon the best scheme."

I can say with Rice Vaughan that "my scope was not to render the reader able to find out the fittest course to govern this matter of money and coin, but able to judge of what should be propounded by others;" but we need no longer fear the state of things described by him when he says "that for want of that ability the wisest States and the greatest Councils of Christendom, for many ages, have been abused by mysterious names and perplexed subtleties of Mint-men."

* Since the above was written I find that Mr. J. B. Martin incidentally pointed to this analogy in a paper read before the Institute of Bankers in March last.

NOTICES OF BOOKS.

Tables to Facilitate Chemical Calculations. Compiled by W. Dittmar, F.R.S., with the assistance of J. McArthur, A. Kling, and T. Barbour. Glasgow: Robert Maclehose, 1884.

The practical value of such a set of tables as is brought together in this little manual by Prof. Dittmar is unquestionable, and the compiler's extensive experience as a teacher of chemistry has enabled him fully to appreciate the wants of analytical chemists and to make a judicious selection and arrangement of his materials that will render his book serviceable to analyst as well as student. Logarithms are presumed by the compiler to be employed by the chemist in his calculations, and to render the work complete a four-place table of these functions is given with a simple device in arranging the "proportional parts" by means of which a fifth unit may be obtained. By this means all the logarithms required in the vast majority of chemical calculations are condensed into a few pages; chemical operations unfortunately not having yet reached that degree of accuracy to require a student to wade through a treatise on Finite Differences, to understand and apply such an interpolation formula as that established by Lagrange or Euler to his logarithms. In some parts of the notes explanatory of the use of logarithms and the mode of manipulating the "proportional parts," we think the algebraical refinements will be apt to bewilder many chemists.

In the atomic weights the compiler takes Meyer and Seubert's calculations, but with O = 16 and the ratio O : H equal to 15·96, thus leaving the chemist without a unit in these numbers. We might well ask, O is 16 what? A table of reciprocals is also given which must prove serviceable in many chemical calculations.

The tables for the calculation of chemical formulæ and for formula-values and analytical factors, will be appreciated by the analyst who has many of such calculations to perform. In the latter we notice such expressions as "$6FeSO_47H_2O$" and "$2FeSO_47H_2O$," which, without brackets, are liable to be confounded with something other than their true meaning. This, however, is of very slight consequence if the numerical factors attached are correct; when, however, we see the ratio of $3Li_2O : 2LiPO_4$ (*sic*) given as 0·3573 with the corresponding log, it is of more serious importance. How this result is obtained is difficult to see; if, however, instead of the usual molecular weight of Li_3PO_4 of 116·1 we take 126·1, the above factor may be obtained.

The "Rules of Gasometry" are given in a very general and concise manner, but we think it an omission not to have devoted a paragraph to the algebraical formulæ required for the calculations of the results of gas analyses by combustion. The density of water at different temperatures according to Rosetti's calculations, as well as the density of mercury, will be found useful in calibrating operations.

The coefficients of absorption of nitrogen, oxygen, and air by water that are given are taken from the compiler's "Memoir on the Composition of Ocean Water" in the *Challenger* reports.

CORRESPONDENCE.

SALICYLIC ACID.

To the Editor of the Chemical News.

Sir,—I have seen in a local newspaper a grocer complaining of having found a quantity of salicylic acid in tinned salmon, lobsters, and tinned fruits, and in which he in writing seems to convey that it is a poison, but not regarded as such in this country. And he states that in France it is believed to be a poison, and is forbidden by legal statute to be used in any preparation of food or drink, under a heavy penalty.

And now as this article is used very largely in the preparation of tinned meats and fruits, and is looked upon as a poison by some, I should feel obliged if some fellow readers would kindly give their opinion on the subject of its poisonous or non-poisonous nature?

In 1881 the French Minister of Commerce, it is stated, directed that an analysis of its properties should be made. The result of the investigation decided that salicylic acid was injurious to health by its direct action on the system, and its indirect action by permitting the fraudulent introduction into food of other deleterious, or at least unwholesome, substances. This action on the part of the Minister of Commerce led to great dissatisfaction on the part of most French pharmaciens and analysts, as about that time salicylic acid was creating a perfect *furore* amongst the gout and rheumatic suffering public of France.

It is, I believe, becoming a practice to use this antiseptic in the preservation of fruit, as by doing so it may be preserved without boiling, and does not lose its flavour; the medicinal dose of salicylic acid, I believe, is from 10 to 30 grains, and as 15 grains would be enough to preserve a tin of fruit, or keep a tin of salmon or lobsters, if so used I do not see the danger —I am, &c.,

J. H. Heywood.

Rochdale.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwis expressed.

Zeitschrift für Analytische Chemie.
Vol. xxiii., Part 3, 1884.

A Contribution to the Chemistry of Wine.—R. Kayser.—The author's results are given in the form of tables and no not admit of useful abridgment.

Contributions to the Analysis of Wine.—Dr. J. Nessler and Dr. M. Barth.—In this portion of their treatise the authors treat of the quantitative determination of magenta in red wines, the determination of tannin, and the volatility of glycerin at 100° in presence of aqueous and alcoholic vapours.

Simple Process for the Approximate Determination of Carbonic Acid in the air of Inhabited Rooms and in other Gaseous Mixtures.—R. Blochmann.—A given quantity of lime-water of known strength is brought in contact with so much of the air in question that the carbonic acid present is exactly sufficient for its saturation. In order to detect the point of saturation there are added to the lime-water a few drops of a dilute solution of phenol phthaleine, until it appears distinctly red. This colour remains as long as the liquid retains an alkaline reaction, but as soon as the conversion of the caustic lime into calcium carbonate is complete a very small excess of carbonic acid is sufficient for complete decolouration.

Remarks on a Communication by Prof. Clemens Winkler on an Absorption Apparatus for Elementary Analysis.—W. Mathesius.—This paper will be inserted in full.

Analysis of Antimony Alloys, such as Type-Metal, consisting of Lead, Antimony, and Tin.—Fr. Weil.—Inserted in full.

Paratoluidin Sulphate as a Reagent for Nitric Acid.—Antonio Longi.—(See page 168.)

Examination of Potable Water.—W. Bachmeyer.—Already inserted.

Determination of the Technical Value of Calcium Tartrate.—L. Weigert.—This paper will be reproduced in full at the earliest opportunity.

Remarks on Apparatus for Fractionated Distillation. L. Weigert.—This memoir cannot be usefully abstracted without the accompanying illustration.

An Apparatus to Supersede Shaking up with Ether, Ligroine, &c.—Dr. H. Schwarz.

Apparatus for the Technical Determination of Carbonic Acid and Carbonates.—Prof. R. Baur.—

Platinum Filters.—A. Gawalovski.—These papers all require the accompanying illustrations.

Ether Capsules.—A. Gawalovski.—Analysts who have to evaporate ethereal extracts, especially those of fatty oils, find that the last traces of the water present in the ether are difficult to drive off, either on the water-bath or in the air-bath. The author overcomes this diffieulty by the use of very flat capsules of glass or porcelain with a diametrical ridge or dam in the bottom.

Reply to Herr Kissling's Public Challenge.—Dr. Skalweit.—This controversy is of too little general interest for reproduction in the Chemical News.

The Determination of Arsenic.—Carl Holthof.—This memoir will be reproduced at considerable length at the earliest opportunity.

Conclusions of the Commission Nominated by the Imperial Sanitary Office for Agreeing on Methods for the Examination of Wines.—This paper does not admit of abridgment.

The Dependence of the Boiling-Point on Atmospheric Pressure.—G. W. A. Kahlbaum.—The author refutes the common assumption that a reduction of pressure equal to 1 centimetre corresponds to a reduction of the boiling-point by 1°.

Tension of Mecurial Vapour at Low Temperatures.—H. McLeod and R. Warder.—From the Chemical News.

Apparatus for the Reduction of Measured Volumes of Gases to the Normal Condition.—U. Kreusler.—This paper requires the two accompanying figures.

A Thermo-regulator.—V. H. Veley. — From the *Journal of the Chemical Society*.

Improved Apparatus for Evaporating Liquids in a Vacuum.—H. McLeod.—From the *Journal of the Chemical Society*.

A Pressure-flask for the Saccharification of Starch.—F. Allihn.—This apparatus cannot be intelligibly described without the accompanying illustration.

Closing Absorption-Tubes. — R. Muencke. — The author uses ground glass stoppers which are hollow and have a lateral orifice. The arrangement is quite analogous to that proposed by Chancel for his apparatus for determining the specific gravity of gases.

Self-acting Apparatus for Filtration and Washing.—E. E. Robinson.—From the Chemical News.

An Improved Refrigerator.—F. Simand.—This apparatus can be used without alteration either in distilling or as a cohobator.

Preparation of Pure Hydrochloric Acid. — G. Giudice.—To the sulphuric acid used for liberating the hydrochloric gas is added a small quantity of an oxidising body (potassium dichromate or permanganate, pyrolusite, &c.), and the gas before absorbing it in water is washed in mercury. The object is to prevent the formation of sulphurous acid and to keep back bromine, iodine, and arsenic chloride.

Determination of Potassium and Sodium in the Ashes of Plants and in similar Substances.—C. Richardson.—The author shows that the method used for separating the alkaline chlorides from the ashes of plants does not yield them in such a state of purity that the respective proportions of sodium and potassium can be determined from the chlorine present. The alkaline chlorides are frequently accompanied by phosphoric acid and magnesia, which latter ingredient can be entirely removed only in the absence of the more energetic acids. To this end the author dissolves the ash in nitric acid, evaporates repeatedly with addition of nitric acid to expel all chlorine, takes up in water, adds a few grms. oxalic acid, evaporates again once or twice on the water-bath, and ignites gently

The residue, consisting of carbonates, phosphates, and sulphates, is dissolved in water and filtered, through the smallest filter possible. The filtrate is then mixed with a slight excess of barium hydroxide, boiled up, and filtered. The solution then contains merely the alkalies as hydroxides and the excess of baryta. In order to remove with certainty any remaining traces of magnesia the solution is once more evaporated to dryness, the residue repeatedly extracted with small quantities of water each not exceeding 5 c.c., and filtered through a filter of 7 centimetres in diameter. To the filtrate is added a boiling solution of ammonium carbonate; it is evaporated to dryness, redissolved in water, and filtered into a weighed platinum capsule. The carbonates are converted into chlorides by the addition of hydrochloric acid. If, after evaporation and gentle ignition, there appears a carbonaceous residue, it must be removed by filtration. The alkaline chlorides thus obtained are perfectly pure and fit for the determination of the chlorine. By means of this method the author found in the ashes of many plants far lower proportions of soda than had been obtained in former analyses. He justly ascribes this result to the circumstance that on determining the potassium as potassium-platinum chloride in impure alkaline chlorides all the impurities are calculated as soda.

Detection and Determination of Titanium.—A. Weller.—This paper will be inserted in full.

Electrolysis of Bismuth.—The electrolytic determination of bismuth, according to C. Luckow, A. Classen, M. A. von Reis, and Schucht, is attended with some difficulties, since the metal is not always separated in a compact state, and some peroxide is easily deposited at the positive electrode. To obviate these inconveniences H. W. Thomas and E. F. Smith perform the operation in the solution of the sulphate, in the alkaline solution of the citrate, or in the solution of the latter in presence of free citric acid. The authors employed a solution of bismuth sulphate containing in 10 c.c. 0·03 to 0·04 grm. bismuth and very little free sulphuric acid, and introduced it into a small platinum crucible surrounded by a strong copper wire in connection with the positive pole. The current is generated by a bichromate battery of three elements and the action lasted for three hours. On interrupting the circuit the liquid was without delay emptied out of the crucible, and the bismuth, which had been completely deposited in a compact form, was washed with water and alcohol, dried, and weighed. When larger volumes of liquid were used, such as 100 c.c. containing 0·03 to 0·04 grm., the authors placed the solution of bismuth sulphate in a beaker in which the platinum crucible connected with the negative pole was immersed, whilst a platinum wire connected with the positive pole was led under the crucible. The current was interrupted after five hours, when the entire bismuth was found deposited in a compact form on the outside of the crucible. Similarly successful results were obtained with solutions of bismuch citrate mixed either with soda-lye or with free citric acid. The application of heat does not accelerate the precipitation of bismuth. Peroxide was deposited only in a few cases when the current was too feeble, which, however, always disappeared again before it was interrupted.

Determination of Molybdenum.—Otto Baron von der Pfordten.

Determination of Phosphoric Acid.—Otto Baron von der Pfordten.—These two papers will be inserted at length.

Determination of Chlorine, Sulphuric Acid, and Chrome, in Presence of Organic Matter.—O. T. Pomeroy.—The determination of chrome in presence of organic matter is practicable only if such matter is destroyed by fusion with sodium carbonate and saltpetre. But as a part of the nitrate is thus converted into nitrite, after acidifying a part of the chromic acid is reduced and chromium chloride is formed, which interferes with the determination of chlorine by means of silver nitrate. The determination of sulphuric acid is also inaccurate in presence of chromic acid. It is therefore necessary after the destruction of the organic matter to convert the chromic acid entirely into chromium oxide, and to remove it before determining the chlorine and the sulphuric acid. The authors effect this reduction by means of nitric acid and a nitrite. The watery solution of the melt is mixed with potassium, sodium, or ammonium nitrite, and with an excess of nitric acid. After standing for about twelve hours in the cold the mixture is supersaturated with ammonia, boiled, and the precipitated chromium hydroxide is determined as usual. After the filtrate has been again acidified with nitric acid the sulphuric acid is precipitated with barium nitrate. It is necessary to purify the barium sulphate by fusion with sodium carbonate and to re-precipitate the sulphate. In the filtrate the chlorine is then determined in the ordinary manner. If only sulphuric acid and chrome have to be determined the reduction of the chromic acid by means of a nitrite and nitric acid can be effected at a boil, and takes place then immediately. The author recommends this method also for the examination of commercial chrome-yellow. The lead, even though present as sulphate or chloride, dissolves perfectly after adding a sufficiency of sodium nitrite and nitric acid and boiling the mixture. The author prepares pure sodium nitrite, free from sulphates and chlorides by heating pure saltpetre for some time to a red heat in a closed iron vessel, dissolving the mass in water and filtering. He purifies crude sodium nitrite by dissolving in water, filtering, precipitating sulphuric acid if present with barium nitrate, removing the latter with sodium carbonate, acidifying the filtrate with nitric acid, and heating with the occasional addition of small quantities of the latter acid until the liquid is free from chlorine. It is then neutralised with sodium carbonate and allowed to crystallise.

A Reaction for Alcohol.—It has been proposed to bring the substance in question into contact with a solution of molybdic acid in strong sulphuric acid, when the presence of alcohol is indicated by a fine blue colouration. Messrs. Gladstone and Tribe have shown that this reaction is inconclusive, since a series of other reducing agents produce the same effect.

A New Colour Reaction of Amylic Alcohol.—M. Vitali.—Equal volumes of amylic alcohol and sulphuric acid produce at common temperatures a dirty red colouration. If the quantity of amylic alcohol is doubled, the colour becomes cherry-red and then violet. Five to six additional volumes of amylic alcohol give an azure blue colour, and larger proportions of amylic alcohol produce a green. An addition of ether makes the colours more brilliant. If the green liquid is evaported it takes again a blue and a violet colour, especially on the sides of the capsule. If upon a small quantity of sulphuric acid there is poured amylic alcohol, and if the acid is cautiously stirred with a glass rod the colours appear in the same order as more and more amylic alcohol mixes with the sulphuric acid. In this manner the reaction can be used in testing alcohol for fusel oil in Betelli's method to demonstrate that the residue obtained by shaking up with chloroform is really amylic alcohol.

Detection of Glycerin and Lignine.—C. Reichl.—The author utilises the colours which these substances give when treated with pyrogallic acid and stannic chloride. If a little of the substance supposed to contain glycerin is boiled with a little pyrogallic acid, a few drops of sulphuric acid, previously diluted with an equal volume of water, if the smallest quantity of glycerin is present, there appears a distinct red colouration, which turns to a fine violet-red on the addition of a solution of stannic chloride. Carbohydrates and certain alcohols must not be present, as they produce similar colourations. Lignine takes a fine violet colour colour if boiled with pyrogallic acid and stannic chlorlde. Pure cellulose remains colourless.

Bettel's Process for the Determination of Nitrogen.—H. Bungener and L. Fries.—These authors have modified Bettel's apparatus in a manner which Fresenius does not think advantageous.

Colorimetric Determination of Grape Sugar in Presence of Cane-Sugar.—A. Vivien.—The author dissolves 10 grms. of the sample in 200 c.c. water, adds 10 c.c. of a copper solution for the reduction of which 10 milligrms. of grape sugar are required, and boils. Complete decolouration occurs only if at least 10 milligrms., *i.e.*, 0·1 per cent of grape sugar is present. If only smaller quantities exist in the mixture the colour of the liquid is compared with that of 10 liquids similarly treated, containing respectively 0, 1, 2, &c., milligrms. of grape sugar.

Determination of Tannin.—E. Johanson.—The precipitation of tannin by a solution of gelatin is effected more completely and in a better condition for filtration, if, besides ammonium chloride, as proposed by Schulze and Lehmann, there is also added a small quantity of chromium sulphate or of chrome-alum. The author proceeds in the same manner as Lehmann, but he adds to 100 c.c. of the solution containing sal-ammoniac from 5 to 8 drops of a solution containing 1 part chromium sulphate in 25 parts of water. In order to ascertain the end of the reaction he filters small quantities into two test glasses of equal width, adds to the one a few drops of a solution of gelatin, observing if the two liquids, when held up against a sheet of black glazed paper, appear opaque or transparent. As long as a precipitate is formed these portions and the washings of the little filters are poured back to the main quantity. If acetic or tartaric acid is present the liquid should be neutralised before proceeding to the determination. Johanson points out that though this method gives good results with the tannin of galls and of oak-bark, an extract of coffee gives no precipitate with solution of gelatin, so that caffeo-tannic acid cannot be determined in this manner. This shows that only quantities of tannin of one and the same kind can be compared with each other.

Analysis of Milk.—J. Uffelmann.—Fuchs had previously shown that the presence of nitric acid in milk indicates the previous addition of an impure water contaminated with nitric acid. Uffelmann has further worked out this method so as to take cognisance of ammonia and nitrous acid. He mixes 350 c.c. of milk with dilute acetic acid until the caseine is entirely thrown down; 100 c.c. of the filtrate are mixed with three drops of hydrochloric acid, boiled up, let cool, and filtered. Of this new filtrate 50 c.c. are rendered faintly alkaline with pure potassa-lye, filtered, distilled, and the distillate is tested with Nessler's reagent. To the remaining 50 c.c. are added sodium hydroxide and carbonate, the mixture is filtered, and tested with Nessler's reagent. The residue of the liquid filtered from the acetic acid precipitate is boiled and filtered. 30 c.c. are tested with meta-phenylen-diamine (diamidobenzol) another 30 c.c. with zinc-iodide-starch paste for nitrous acid. The remainder is utilised for detecting nitrates by means of diphenylamin. A little crystalline diphenylamin is dissolved in a white capsule in about 1·5 c.c. of pure sulphuric acid (full strength) and 3 to 4 drops of the milk filtrate are added. In presence of much nitric acid there is formed almost instantly a blue zone, which quickly extends. If there is little nitric acid the colour appears only after some time. If the blue colour does not appear the experiment is successively repeated with portions of the milk-filtrate, concentrated respectively to one-third, one-seventh, and one-tenth of the original volume. Neither ammonia, nitric nor nitrous acid, is present in normal milk, but all three may be introduced by sophistication with impure well-water.

Examination of Confectionery and Fruit Syrups.—E. Johanson.—In mixtures obtained by boiling down acid liquids with cane-sugar the author found that 15 to 20 per cent and even more of the saccharose was converted into reducing sugars.

Cocoa and Chocolate.—M. Boussingault.—This paper contains nothing new from an analytical point of view.

Examination of Beer.—E. Johanson.—The author maintains that the consumption of recent beer is injurious to health. He states that such beer is scarcely rendered turbid by potassium mercuric iodide, whilst beers which have remained in store for three months give flocculent precipitates with the same reagent.

Examination of Lubricating Oils.—W. Fox.—From the *Analyst*.

Genuine Cod-liver Oil.—H. Meyer.—The author mixes in a stoppered glass 10 parts of the sample with exactly 1 part of a mixture of equal parts of strong sulphuric and nitric acids. The pure oil of *Gadus morrhua* turns to a fiery rose, and then quickly to a lemon-yellow. That of the "haak-jaerring" turns also to a rose, but then to a brownish violet. The oils of the remaining *Gadidæ* turn also yellowish, but of a less pure tone. This reaction is to be applied with caution, as all colour reactions of oils are modified by a variety of circumstances.

Contributions to the Chemistry of Lignification.—C. F. Cross and E. J. Bevan.—From the *Journal of the Chemical Society*.

Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—Already noticed under *Comptes Rendus*.

Determination of Reverted Phosphoric Acid.—Brief mention of a number of memoirs.

Azotometric Examination of Ammoniacal Manures.—Marez Massalski.—Noticed under *Bulletin de la Soc. Chimique de Paris*.

Detection of Arsenic in Ferrum Pulveratum.—H. Beckurtz and O. Schlickum.—No particulars are given.

Examination of Potassium Bromide.—G. Vulpius.—The author proceeds iodometrically: 0·10 grm. of the sample and 2 grms. potassium iodide are dissolved in 5 grms. hot water in a beaker; 10 grms. cold distilled water and 15 grms. of pure hydrochloric acid at 25 per cent are added, and finally the iodine liberated is either titrated directly with sodium hyposulphite or an excess of the latter is added and titrated back with iodine and starch.

Examination of Tartaric and Citric Acid.—R. Otto.—The presence of gypsum in tartaric acid is more distinctly shown by means of ammonium oxalate if the acid has been approximately neutralised with ammonia. With citric acid the reverse holds good. Sulphuric acid is more readily detected by means of barium nitrate, both in tartaric and citric acids if they have not been neutralised. For the detection of tartaric acid in citric acid Push heats 1 grm. of the pulverised sample with 10 grms. pure sulphuric acid in a dry test-tube for an hour. The tube is placed in a water-bath heated almost to a boil. The sample melts to a lemon-yellow liquid, and if pure retains this colour for an hour. If even half per cent tartaric acid is present the liquid becomes brownish in thirty minutes, and in an hour reddish brown.

Valuation of Radix Belladonnæ.—Prof. Redwood.—From the *Pharmaceutical Journal and Transactions*.

Detection and Determination of Iodine in Urine.—E. Harnack.—For the detection of iodine in urine the author recommends a combination of the starch and the carbon disulphide methods. In case of minute traces of iodine, where the simple starch tests gives no colouration, if carbon disulphide is simultaneously present, there is gradually formed a narrow ring of colour where the two liquids come in contact.

Alkaline Bismuth Solution as a Reagent for Starch Sugar in Urine.—E. Nylander.—The author dissolves 2 grms. basic bismuth nitrate and 4 grms. Seignette salt in 100 grms. of a soda-lye containing 8 per cent sodium

oxide, filtering off any undissolved bismuth salt. One part of this reagent must be added to to 10 parts of the urine.

Robert's Process for Determining Starch-Sugar in Urine.—W. Müller.—In this process the sugar is calculated from the decrease of density in the urine after fermentation with yeast. Müller finds that by this process the sugar can be determined to 0·5 per cent. The specific gravity must be determined by means of the pyknometer.

Detection of Morphine in Animal Tissues and Excretions.—In some cases morphine is converted in the living animal into oxy-dimorphine, a more poisonous substance, which produces symptoms differing from those of morphine, and resembling rather those met with in in arsenical poisoning.

Determination of Albumenoids in Human Milk.—E. Pfeiffer.—The author's researches relate to the precipitation of caseine by acids, and to the determination of the total albumenoids according to the methods hitherto proposed.

Determination of Chloroform in the Blood of Animals which have been subjected to Anæsthesis.—MM. Gréhant and Quinquaud.—From the *Comptes Rendus*.

Examination of Blood-spots.—C. Husson.—From the *Comptes Rendus*.

On Ptomaines.—A collection of references to the *Comptes Rendus* and the *Berichte der Deutsch Chem. Gesellschaft*.

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 3, August 5, 1884.

New Method for the Synthesis of Nitrogenous Organic Compounds: Synthesis of Xanthine and Methyl-xanthine.—M. Arm. Gautier.—In order to produce xanthine and methyl-xanthine the author heats a mixture of hydrocyanic acid, water, and acetic acid, the last body in such quantity that the liquid may not become alkaline, it being merely requisite to saturate the ammonia which tends to form. When the operation has succeeded, the contents of the tubes are maroon or reddish brown, and is composed of two portions. The one, soluble in cold water, contains aldehydic acids of a very interesting constitution, which the author is examining, and a yellow matter soluble in alcohol, which becoming oxidised in the air gives a slate-blue substance, the potassic solution of which stains paper a splendid indigo-blue. This same solution, if made in the cold and treated with hydrochloric acid in excess, deposits gradually on exposure to the air a compound in purple microscopic crystals with a golden-green reflection. This is a feeble acid, probably diatomic. The portion insoluble in cold water is taken up in boiling water acidulated with acetic acid. On cooling there is formed a precipitate which is boiled, re-dissolved in hydrochloric acid, neutralised with ammonia, filtered to separate impurities, and finally treated with copper acetate. On boiling there is deposited a mixture of copper xanthate and methyl-xanthate. If in the reaction above described there are substituted for water the mono-atomic or poly-atomic alcohols, the acetones, aldehydes, phenols, &c., or if in turn there are substituted for hydrocyanic acid the various carbylamines we obtain an almost indefinite series of new bodies, basic, acid, or neutral. The author considers that the mechanism of the syntheses of which a sketch has been given appears very similar to, if not identical with, that which takes place in vegetables.

Sterilisation of Fermentible Liquids in the Cold.—A. Gautier.—After pointing out the inconveniences of sterilisation by heat, the author proposes filters made of porcelain, deprived of its glaze, or of earthenware in the form of bottles with long, narrow neck. The bottom of the filter-bottle has the shape of an inverted cone. A thick glass tube penetrates by the neck down to the bottom; above the neck it is bent at a right angle, and ends in a conical point ground with emery. The tube is cemented to the neck of the bottle by a lead boro-silicate, consisting of crystalline boric acid 8 parts, silica 2 parts, red lead 12 parts. These substances are melted together, pulverised finely, worked up with oil of turpentine, applied with a brush to the part which is to be cemented, and heated to redness. The bottle, when thus connected and thoroughly "flambée" on Pasteur's method, is exhausted of air and plunged into the liquid to be filtered, which passes from without inwards. The properties of various organic fluids are much modified after filtration. We may hence infer the alterations which the plasmas of the organic economy must undergo after filtration by endosmosis through animal or vegetal membranes.

A New Alcohol, extracted from Bird-lime.—J. Personne.—The new compound, ilicic alcohol, has the composition $C_{50}H_{44}O_2$. It is insoluble in cold water, slightly soluble in dilute ethylic alcohol, soluble in almost all proportions in ethylic alcohol at 90° per cent; fuses at 175°, and boils at 350°.

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ALEX. MOORE, C.A.,
Secretary.

Glasgow, 128, Hope Street,
September, 1884.

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VOL. L. No. 1299.

ON THE BOILING-POINT OF HYDROGEN.

By EDMUND J. MILLS, D.Sc, F.R.S.

IN a recent memoir (*Phil. Mag.*, [5] xvii., 173) I showed that the boiling-point y of any member of a homologous series is related as follows to the coefficient x of C in its formula,—

$$y = \frac{\beta(x-c)}{1+\gamma(x-c)},$$

c being the value of x to which zero Centigrade corresponds, and β, γ constants depending on pressure and other conditions. Thus, the equation to the series of olefines in which x is even is—

$$y = \frac{40{\cdot}709\ (x-4{\cdot}228)}{1+0{\cdot}060123\ (x-4{\cdot}228)}$$

Putting $x = 2$, $y = -104{\cdot}7°$, the calculated boiling-point, at the ordinary pressure, of common olefiant gas. Olzewski (*Comptes Rendus*, xcix., 133) has since found that olefiant gas boils at $-103°$ under a pressure of 750 m.m.

The satisfactory character of this result has induced me to calculate the boiling-point of hydrogen. It is perfectly clear, and has been long since supposed, that hydrogen (H_2) is, or may be, the "origin" of the series of paraffins, C_nH_{2n+2}. In the memoir referred to, the boiling-points of the normal paraffins were discussed, and equations found for them. There are in all four series to deal with, viz., the even and odd series under ordinary pressure, and the same series under a pressure of 15 m.m., the latter having been worked out by Krafft's.

The equation for the even series is—

$$y = \frac{39{\cdot}315\ (x-3{\cdot}94)}{1+0{\cdot}070753\ (x-3{\cdot}94)}$$

and for the odd series,—

$$y = \frac{38{\cdot}992\ (x-3{\cdot}92)}{1+0{\cdot}070564\ (x-3{\cdot}92)}$$

Under 15 m.m., the equation to the even series is—

$$y = \frac{23{\cdot}154\ (x-7{\cdot}1)}{1+0{\cdot}035484(x-7{\cdot}1)},$$

and to the odd series—

$$y = \frac{21{\cdot}685\ (x-6{\cdot}77)}{1+0{\cdot}030437(x-6{\cdot}77)},$$

When in each of these four equations we put $x=0$, the results are—

	y.
Even	−214·77
Odd.	211·29
Even (15 m.m.)	219·76
Odd (15 m.m.)	184·91

The discordance between the results for the odd series, as compared with those of the even series, shows that hydrogen is certainly not the origin of the odd series of paraffins. The two results, however, for the even series amply support each other, and show the boiling-point of hydrogen to be about $-215°$ C.

Messrs. Wroblewski and Olzewski are understood to be separately engaged in the investigation of this subject. According to the former (*Comptes Rendus*, xcviii., 982) oxygen and nitrogen boil respectively at $-184°$ and $-193°$ under the ordinary pressure, and the temperature at which hydrogen liquefies is not greatly distant from $-184°$. These temperatures were measured thermo-electrically. Olzewski, who uses a hydrogen thermometer, has also liquefied hydrogen, and alleges that he has measured a temperature of $-213°$ C. (*ibid.*, xcix., 134.)

The question will probably be settled at an early date; but it is clear that the experimental number is not likely to differ greatly from $-215°$ C.

Glasgow, Sept. 29, 1884.

ESTIMATION OF TANNIC ACID BY CARBONATE OF LEAD.

By ROBERT JACKSON, F.C.S.

AN easy and satisfactory method of determining the amount of tannin in the materials used in the manufacture of leather, or in the liquors in operation in tanneries, not having been yet devised, I beg to submit the results of a few experiments on the subject, which may be of use to tanners and others not sufficiently skilled to obtain satisfactory results by Lowenthal's method.

50 grms. of English oak-bark were exhausted by four successive boilings in distilled water, and the extract made up to a litre at 60° F.: the density was 1003·86. Dry powdered carbonate of lead was then added, and the liquid shaken occasionally for two or three hours: the density of the clear filtrate was 1001·52, giving a loss of density of 2·34.

Previous experiments showed that 1 per cent of tannic acid in distilled water at 60° F. gave a density of 1003·8, and higher and lower amounts proportional densities.

Taking the loss of density of the bark extract 2·34, dividing by 3·8, and multiplying by 20, shows 12·30 per cent removed by carbonate of lead. A sample of good Irish oak-bark similarly treated gave a density of 1004·70, before the addition of the carbonate of lead, and 1001·68 after, showing a loss of 3·02.

$$\frac{3{\cdot}02}{3{\cdot}8} \times 20{\cdot}0 = 15{\cdot}88 \text{ per cent}$$

The following are the results obtained on treating various other samples by the same process.

The solutions are all of 5 per cent strength, with the exception of the tan liquors, which were tried as received.

Material.	Density.	After Lead.	Per cent.
Valonia	1009·08	1003·33	30·2
Sumach	1008·25	1003·61	24·4
,, ...	1009·61	1005·08	23·8
Oakwood extract, 27 B...	1007·33	1003·15	21·9
,, ,, 29 B...	1007·20	1002·47	24·8
,, ,, 29 B...	1007·66	1002·80	25·5
Chestnut extract, 20 B...	1006·06	1002·48	18·8
,, ,, 26 B...	1007·68	1003·12	24·0
Tan liquor	1019·16	1012 86	1·65
,, ...	1019·15	1012·52	1·74
,, ...	1019·20	1012·32	1·81
,, ...	1007·26	1005·06	0·57

The insoluble matter in the oakwood extracts varies from 6 to 9 per cent.

18, Harrington St., Dublin.

The Antiseptic Properties of Carbon Disulphide.—Ckiandi Bey.—Carbon disulphide is soluble in water to the extent of 0·50 grm. per litre. The solution arrests all fermentations and kills microbia. During twenty years' experience the author has never known a case of paralysis among the workmen constantly exposed to the fumes.—*Comptes Rendus.*

PROPOSALS FOR UNIFORM METHODS FOR THE DETERMINATION OF NITROGEN.

Translated and Contributed by H. H. B. SHEPHERD.

At the instance of the German Manure Manufacturers' Association a General Meeting of Chemists was held in Wiesbaden at the end of last May under the presidency of Prof. Fresenius, to consider the proposals for uniform methods for nitrogen determination brought forward by the Commission appointed at the Hamburg Meeting of German Manure Manufacturers. The report was laid before the meeting by Dr. O. Pieper, of Hamburg, and the proposals were accepted in the following terms:—

A. *Preparation of the Samples.*

The entire sample is to be reduced to as fine a degree as possible and carefully mixed. Dry samples to be so finely powdered that they will completely pass through a sieve of 1 m.m. meshes. Damp samples, such as sulphate of ammonia, nitrate of soda, &c., which cannot be sifted are to be simply rubbed fine in a mortar and well mixed up. The unused portion of the sample to be kept in a well-closed glass bottle for eventual reference.

If the material is coarse and irregular, 400 grms. at the least must be sent for analysis, and, if fine and uniform, at least 200 grms. Should, however, a still larger sample be sent, it is to be carefully mixed and either 400 grms. or 200 grms. taken as the case may require.

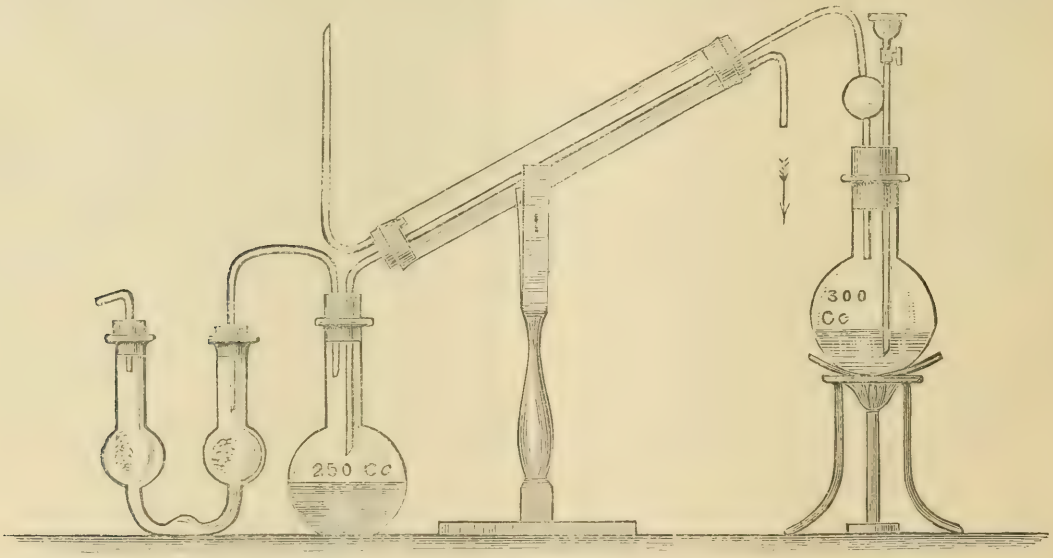
B. *Determination of Nitrogen.*

Nitrogen is usually determined by conversion into ammonia and titration. For the acid, normal or half-normal sulphuric acid is recommended, and for the alkali, a half-normal soda solution, an ammonia solution, or baryta water. The two last-named solutions must, however, in no case be stronger than half-normal.

For the indicator we recommend tincture of cochineal, which is best prepared in the following manner: six grms. of cochineal are finely powdered and digested for several hours at the ordinary temperature with half a litre of a mixture of 300 c.c. water and 200 c.c. alcohol. The solution is then filtered through a Swedish filter and preserved in well-stoppered bottles.

I. *Sulphate of Ammonia.*

This determination is effected by distilling off the ammonia by means of calcined magnesia. The apparatus shown in the following sketch serves for this purpose.



In using the apparatus the following precautions must be observed: (1). That the steam containing the ammonia be condensed by cooling as it passes over; (2). That the tube of the condenser does not dip beneath the sulphuric acid in the flask; and (3). That the complete absorption of the ammonia be secured by the use of a small U-tube.

Ten grms. are dissolved in a half litre of water free from ammonia. The normal acid coloured with cochineal is introduced into the two receivers in the proportion of about 18 c.c. in the flask to 2 c.c. in the U-tube. The receivers are then tightly fixed to the apparatus, and two grms. of calcined magnesia, 25 c.c. of water, and 50 c.c. of the prepared solution = 1 grm. of substance introduced into the distilling flask. (Solution of soda is on no account to be used for distilling off the ammonia). The flask being then tightly fixed to the apparatus, its contents are heated to boiling by a lamp placed underneath and distilled nearly to dryness. During the distillation a slow stream of cold water is allowed to flow through the condenser. Thn distillation proceeds regularly without any bumping and needs no further attention. At the conclusion the stopcock of the distilling flask is opened and a slow stream of air drawn through the apparatus by suction from the U tube.

(*a*). The determination can also be made by means of the azotometer.

(*b*). Further, the method of combustion with soda-lime with the addition of sugar in a tube 34 c.m. long is thoroughly trustworthy if care be taken with the manipulation.

II. *Organic Nitrogen, e.g. Blood, Horn, &c.*

The determination is effected by combustion with soda-lime in the usual combustion-tubes of hard glass.

A few grms. of the sample prepared according to the instructions given in A are rubbed to the finest powder in an agate mortar. Of this, 0·7 grm. if the substance be rich in nitrogen, or 1 grm. if poor in nitrogen is accurately weighed out.

The combustion-tube may conveniently have a length of 41 c.m. and an internal diameter of 1·1 c.m. It is filled as follows:—Sufficient finely powdered soda-lime to form a layer 10 c.m. long is first introduced, then the weighed

portion of the substance for analysis followed by more fine soda-lime sufficient to form a layer about 4 c.m. long. The soda-lime and substance are then intimately mixed together by means of a clean copper wire, taking care that a layer of pure soda-lime about 5 c.m. long remains undisturbed at the end of the tube. The mixture of substance and soda-lime ought only to occupy a length of from 8 to 10 c.m. in the tube. The tube is then filled up with coarsely ground soda-lime, a loose plug of ignited asbestos is inserted, and the U-shaped receiver containing about 14 c.c. of normal sulphuric acid attached to the glass tube by means of a caoutchouc cork. The combustion is to proceed slowly and from the front part of the tube to the end. When the coarse soda-lime in the front part of the tube thoroughly glows, the heating of the substance is commenced gradually, whilst at the same time a few small flames are lighted underneath the turned-up point of the tube. The combustion is to be conducted so that the bubbles pass through the sulphuric acid at regular intervals. It ought not to be prolonged beyond an hour. When properly carried out the sulphuric acid in the U-tube is never coloured. When the acid begins to recede the jets of flame are turned out, the point of the tube broken off, and air is sucked through the combustion-tube.

(*a*). The method of Kjeldahl (*Zeit. f. Analyt. Chemie*, 22, p. 366, *Chemiker Zeitung*, viii., No. 25) is also worth recommending, though further experience of it is needed.

(*b*). The use of iron combustion tubes cannot be generally recommended. They are only allowable with the modifications described by Prof. Paul Wagner (*Chemiker Zeitung*, viii., No. 37).

III. *Determination of Nitric Nitrogen.*

(*a*). Determination by difference. The technical method used for nitrate of soda.

The moisture is determined by drying at 120° C., the muriate by titration with a decinormal silver solution, the sulphate of soda and any insoluble residue by gravimetric analysis. The difference gives the nitrate of soda.

(*b*). By expelling the nitric acid by fusion with silica or acid chromate of potash.

The nitre is first thoroughly dried at a temperature of 120° C., and the loss in weight (=moisture) ascertained. One grm. of the dried nitre is then intimately mixed with six grms. of ignited sand or eight grms. of fused bichromate of potash and the crucible and its contents accurately weighed. It is then heated for 30 minutes, but in such a manner that only a third part of the bottom of the crucible becomes red-hot. After cooling, the crucible and its contents are again weighed, the loss in weight corresponding to the amount of nitric anhydride contained in the nitre. It is, however, absolutely necessary to take the precaution of repeating the fusion and weighing.

(*c*). Siewert's method, depending upon the conversion of nitric acid into ammonia.

The apparatus recommended for the determination of ammonia is used. The two receivers are arranged as directed in I. Into the distilling flask are introduced four grms. of iron filings, 10 grms. of zinc powder, 12 grms. of sodic hydrate, 100 c.c. of 90% alcohol, and 50 c.c. of the solution of nitre=one grm. substance. The disengagement of hydrogen begins at once at the ordinary temperature; when, however, it commences to flag, the flask is to be warmed by a small flame, so that a uniform disengagement of gas takes place. When all the alcohol has distilled over, 20 c.c. more is to be run in through the funnel tube and likewise distilled off. To ascertain when the distillation is complete, the caoutchouc cork is loosened from the distilling flask and a strip of moistened red litmus paper squeezed in between the cork and the neck of the flask, observing if it still becomes blue. Should this be the case, 20 c.c alcohol are again to be introduced and the distillation repeated.

(*d*). The Schlöesing-Grandeau method, modified and simplified by Prof. Paul Wagner (*Chemiker Zeitung*, vii., 1710, and viii., 650).

This method depends upon the reduction of the nitric acid to nitric oxide by a hydrochloric acid solution of ferrous chloride, and calculating the nitrogen from the volume of gas obtained. The determination, when performed in the manner described by Prof. Wagner, superseding the use of mercury, and avoiding the necessity of regarding temperature and pressure, is not only rapid, but exact and accurate and much to be recommended.

IV. *Ammoniacal and Organic Nitrogen.*

The determination of the total nitrogen is accomplished by the method described under II. with this modification, that (especially with substances rich in ammonia) a much shorter combustion-tube (about 34 c.m. long) is used, and the substance is mixed with half a grain of finely powdered sugar. The combustion is to be accelerated as much as possible and can be finished in half an hour.

In ammoniated superphosphates the nitrogen is always to be determined in this way, not according to I.

Should separate determinations be required of the amount of nitrogen present as ready formed ammonia and that present as organic nitrogen, the former may be determined according to the method I., and the latter in the residue from the ammoniacal nitrogen determination by method II., after evaporation of the residue with sulphuric acid.

V. *Nitric and Ammoniacal Nitrogen.*

In mixtures containing both nitric and ammoniacal nitrogen, the ammoniacal nitrogen is first determined by distillation according to method I. The receivers are then re-arranged, iron filings, zinc powder, &c., added, and the nitric nitrogen determined by conversion into ammonia according to method III., C.

Or the ammoniacal nitrogen may be determined in one portion of the sample and the nitric acid in a separate portion by the process III., D.

VI. *Organic Nitrogen in the presence of small quantities of Nitric Acid.*

For this determination Ruffle's method is most to be recommended. The nitro-compounds are reduced and converted into ammonia by a mixture of wood charcoal, sulphur, and hyposulphite of soda (sodium thiosulphate). The process is conducted as follows:—Finely powdered soda-lime is intimately mixed with an equal weight of dry hyposulphite of soda; this mixture is held in readiness. The weighed portion of the substance for analysis is mixed with an equal weight of a mixture of equal parts of finely powdered wood charcoal and sulphur. Sufficient of the mixture of soda-lime and hyposulphite is first poured into the combustion-tube to form a layer of about 20 c.m. in length, this is followed by the mixture of substance, wood charcoal and sulphur, and lastly by some more of the mixture of soda-lime and hyposulphite sufficient to form a layer a few c.m. long in the tube. The whole is then well mixed together by means of a spiral copper wire in such a way that about 5 c.m. remains undisturbed at the beginning of the tube. The tube is then filled up with coarsely ground soda-lime. The combustion is conducted in the usual way. As the reagents used may easily contain some nitrogen it is necessary to make a "blank" combustion to ascertain the amount of the error due to this. The amount of the error to be deducted from the determination.

The Commission { Dr. Lüddecke, Nienburg/a/W, Dr. H. Retschy, Lehrte, Dr. Stalmann, Oker, Dr. Oscar Pieper, Hamburg, Mr. Richters, Breslau, Dr. A. Stelling, Wilhelmsburg.

Wiesbaden, June, 1884.

ACROLEIN-UREA.

By ALBERT R. LEEDS.

IN the *Annalen der Chemie und Pharmacie* for 1869 (vol. lxxv., p. 203), Hugo Schiff has described, under the name of acrolureid, a condensation product formed by the union of two molecules of urea with one of acrolein, in accordance with the reaction—

$$2[CO.(NH_2)_2]+C_3H_4O=\left.\begin{matrix}CO.N_2H_3\\CO.N_2H_3\end{matrix}\right\}C_3H_4+H_2O.$$

Without being aware of Schiff's labours, and whilst studying the aldehyd compounds with quite different objects than those followed by Schiff, I obtained the same compound, but had assigned to it a quite different formula. The explanation of these differences becomes apparent on studying the method by which Schiff prepared the compound, since this method did not and could not yield the substance in question. He mixed a concentrated aqueous solution of urea with acrolein, and after his acrylureid had gradually precipitated as small white needles (?) he washed it merely with ether and water, and dried *in vacuo*. He likewise states that powdered urea unites with acrolein directly. "The mixture swells up, and is converted into a white brittle mass, which in some places has an entirely crystalline appearance. By far the greatest portion is intimately mixed with a white porcelain-like product, formed by decomposition of the acrolein." The analysis of this body gave, as might readily have been expected, no satisfactory results. Schiff further states that in various preparations, some of which were prepared at ordinary and others at higher temperatures, he obtained carbon varying between 44 and 47 per cent, and hydrogen between 6·9 and 7·1 per cent. The formula of diacryltriureid requires 42·2 per cent carbon and 6·3 per cent hydrogen. That of acryldiureid, which Schiff adopted, but 38 per cent carbon and 6·3 per cent hydrogen.

Throughout his investigation Schiff worked upon impure substances, and in that way obtained not only varying results, but results which would support no rational formula, the one which he finally adopted—that of diacryltriureid—being altogether erroneous.

In the first experiment made by the author, the acrolein obtained by heating anhydrous glycerin with potassic bisulphate was allowed to distil over directly into an alcoholic solution of urea. A precipitate formed at once, and after a time a considerable amount was obtained, the urea, however, being still in excess. The filtrate was of a reddish colour, and on evaporation yielded a resinous or gummy mass, which could neither be sublimed nor crystallised from solvents. The precipitate left on the filter was of a yellow-white colour, but after repeated treatment with alcohol became quite white, and lost all of the gummy or thick oily substance at first adhering to it.

Its analysis showed that it had been formed by the union, not of two, but of one molecule of urea, with one of acrolein, a molecule of water being eliminated, and the resulting compound having the formula $C_4H_6N_2O$ or $CO(NH)_2C_3H_4$.

	Found.	Theory.
Carbon	49·01	48·98
Hydrogen	6·3	6·12

Not only as originally prepared by repeated purification with alcohol, but also after treatment with carbon disulphide, chloroform, and ether, in all of which it is only slightly soluble, every attempt to obtain it in a crystallised condition was unsuccessful. It did not melt nor sublime, and when strongly heated underwent decomposition. It is readily attracted by nitric acid, but the products of the decomposition were not studied. From its solution in alcohol no precipitate was obtained on the addition of bromine. On treatment with hydrochloric, tartaric, and acetic acids no salts were formed.

The alcoholic extracts were collected, and yielded, after successive solutions in alcohol and precipitation with water, a white substance similar to that above described, and having a melting-point of 185°. Since sufficient of this material could not be obtained to admit of its satisfactory purification and analysis, a much larger amount of urea in alcoholic solution than that used in the foregoing experiments (40 grms.) was treated with acrolein in successive portions in a closed vessel, until after long-continued warming the odour of acrolein ceased to disappear. In this case, unlike the foregoing, no precipitate was formed, nor did any take place until after the addition of water, when a very abundant white amorphous substance was thrown down. This was boiled with alcohol a great many times, each extract affording a white precipitate when diluted with water, and the portion of pure material obtained eventually was not more than that procured in the first instance, when but a small amount of urea was used and the acrolein was not added in excess. The composition of the substance thus obtained was—

$$CO.(NH)_2.C_3H_4,$$

and it was identical in all respects with the substance formed in the first case. From the alcoholic extracts no other substance could be obtained, and the explanation of the small yield of the pure acrolein-urea in the second case was eventually found to be due to the presence of the oily or gummy substance formed as a by-product. The amount of this by-product was apparently much greater in the second case, and explained the non-precipitation of the acrolein-urea until after the addition of water to the original solution of the urea in alcohol. And the tenacity with which it adhered to the acrolein-urea on precipitation with water, and carried it into solution again on each successive boiling with alcohol, explains the very small eventual yield of the pure material. It was also due to the small adherent traces of this oil that the second body, the one soluble in alcohol, had a melting-point of 185°, and was supposed to be something else than the acrolein-urea.

The presence of this oil, which I was unable to isolate, explains all the above difficulties and the erroneous results obtained by Schiff. In conclusion it may be safely stated that, besides the small amount of this oily by-product, the only compound formed by the action of acrolein on urea was that containing the residue from one molecule of urea, the compound $CO.(NH)_2.C_3H_4$.—*Journ. Am. Chem. Soc.*

ANALYSIS OF DRINKING-WATER FOR AMMONIA.*

By Dr. G. GORE, F.R.S.

1. THE object of this research was to render clear, by means of experiment, several points in the analysis of drinking-water. The water employed in the experiments was ordinary potable water of average quality, such as is usually supplied by the Birmingham Corporation Water Department. An analysis of it was made to determine the amount of organic matter in it, according to the method employed by Wanklyn and Chapman,† and the quantities of ammonia obtained were, "free" 0·026, and "albumenoid" 0·138 milligramme per litre or parts per million. (In each of the experiments of distillation described in this paper, small cubes of hard and highly-purified gas-carbon, of close texture, and previously ignited, were added to the water to prevent "bumping" during the process of boiling, and were found very efficacious and durable).

2. As the ammonia, termed "free" in the above process, was obtained by distilling the water after addition of carbonate of sodium, I distilled half a litre of the sample without such addition until fifty cubic centimetres had

* Read before the Birmingham Philosophical Society, June, 1884.
† See "Water Analysis," 5th edition, chapter IV.

passed over. I then added 2·0 c.c. of sensitive "Nessler's reagent" to the distillate, and stood the mixture twelve hours; only a mere trace of opacity or deposit occurred, showing that only a trace, not exceeding 0·002 m.grm. of ammonia, had distilled over.

3. To determine whether, if present in small quantity, ammonia uncombined with acids would come over freely in the first part of the distillate, I added to half a litre of the sample of water aqueous ammonia containing 0·5 m.grm. of absolute ammonia (H_3N), and distilled over 25 c.c., and found in the distillate 0·11 m.grm. of ammonia, showing that about two-tenths of the total amount of ammonia added had come over in the first one-twentieth part of the water. I also added to another half litre of the sample 0·05 m.grm. of ammonia, and distilled over 25 c.c. and tested; the distillate contained 0·019 m.grm. of ammonia, showing that with the more dilute solution about four-tenths of the ammonia had come over in the same proportionate amount of the water. I conclude, therefore, that if the water contains free ammonia (*i.e.*, uncombined with an acid), a large portion of it comes over in the first one-twentieth part distilled, especially with very weak solutions, and that one part of free ammonia in ten million parts of water (and probably in 100 million parts) may be readily found by such means.

4. To determinate whether carbonate of ammonia, if present in the water in minute quantity, would yield free ammonia by simple distillation, I added to half a litre of the sample of water 0·10 m.grm. of transparent carbonate of ammonia (=0·0288 m.grm. of absolute ammonia), and distilled over 25 c.c. and tested; the distillate contained about 0·019 m.grm. of ammonia, or about two-thirds of the total amount added.

5. I also took half a litre of the original sample, distilled over 25 c.c., added Nessler's reagent, and stood six hours; scarcely a trace of ammonia was found. Meanwhile I added 4·0 c.c. of a solution of sal-ammoniac in perfectly pure water (see paragraph 7), containing exactly 0·01 m.grm. of ammonia per c.c., and distilled over 25 c.c. and tested; found 0·024 m.grm. of ammonia, or about three-fifths of the total amount added. Half a litre of the sample, to which had been added 0·10 m.grm. of sulphate of ammonium (=0·02575 m·grm. of ammonia), was treated in an exactly similar way, and gave 0·0125 m.grm. of ammonia, or about one-half the total amount added. And half a litre to which I had added 0·10 m·grm. of phosphate of ammonium (=0·02568 m.grms. of ammonia) gave by the same process 0·0120 m.grm. of ammonia, or half of the total amount added. The following table shows these results more clearly:—

M.grms. of absolute ammonia added.		M.grms. of am. distilled over.	Fractnl. part of total am. added.
0·5	as aqueous. am.	gave 0·11	=0·2
0·05	as ,,	,, 0·019	=0·4
0·028	as carb. ammonm.	,, 0·019	=0·66
0·04	as chloride ,,	,, 0·024	=0·6
0·02575	as sulphate ,,	,, 0·0125	=0·5
0·02568	as phos. ,,	,, 0·0120	=0·5

6. The liberation of ammonia from these salts cannot be explained upon the assumption that the water contained in solution a small amount of alkaline carbonate, or of free alkali, because if such had been present the water would have yielded its ammonia by simple distillation without requiring a previous addition of carbonate of sodium (see paragraphs 1 and 2). It follows also from these results that any ammonia which comes over by simple distillation of such water may be derived either from ammonia or ammoniacal salts dissolved in the water.

7. To determine whether the ammoniacal salts added to the water were dissociated by the heat, I took some ordinary distilled water which I knew contained traces of ammonia, added a few drops of "pure" sulphuric acid to it, and distilled over a considerable quantity, which on testing I found perfectly free from ammonia.* To one-fourth of a litre of this pure water in a retort I added 0·05 m.grm. of sulphate of ammonium (=0·01287 m.grm. of ammonia), and distilled over 25 c.c. and tested it with one 1·0 c.c. of Nessler's reagent; it gave 0·009 m.grm. of ammonia, or nearly three-fourths of the total amount added. I conclude from this result that the ammoniacal salt in this case was dissociated.

8. I subsequently found some compounds containing ammonia, the aqueous solutions of which did not yield ammonia by simple distillation. A solution of chloride of aluminium in pure water gave on distillation not a trace of ammonia, but on distilling it after addition of pure carbonate of sodium it yielded ammonia freely. Also a solution of sulphate of aluminium, or of purified potash-alum, yielded no ammonia on distillation, but gave it freely by distillation after addition of a solution of potash (quite free from ammonia), added in sufficient quantity to re-dissolve all the precipitate. In the "pure" hydrochloric and sulphuric acids of commerce, especially the latter, I also found ammonia freely, and it was not removed from the former acid by distillation with a small quantity, either of sulphuric acid or ignited alumina. As drinking-water does not often contain soluble salts of alumina it follows from the various results obtained that a more correct way of ascertaining if "free" and "saline" ammonia is in it, is by distilling a portion of the water alone.

9. As I found after various trials that chloride or sulphate of aluminium, or potassic alum, perfectly free from ammonia, was not readily obtainable by purchase, I made a nearly saturated solution of crystallised potash-alum, by dissolving 5 grains of it in 60 grains of water free from ammonia, the mixture occupying 65 c.c., and determined the amount of ammonia in it by distilling 10 c.c. of this solution with 10 c.c. of a saturated solution of ammonia, some free sodic carbonate, and 30 c.c. of pure water, until 25 c.c had passed over. The 10 c.c. yielded 0·25 m.grm. of ammonia, or 0·325 part ammonia per one million parts of the alum.

10. As ammoniacal salts, whether neutral or alkaline, when dissolved in water, yielded a large proportion of their ammonia by simple distillation, and as the sample of drinking-water gave scarcely a trace of ammonia by such treatment, it appears that the drinking-water did not contain either ammonia or ammoniacal salts, and that the ammonia liberated from such water by distillation with carbonate of sodium was probably due to the action of the alkaline carbonate either upon nitrogenous organic matter or upon double salts of ammonia and alumina; as, however, a trace of alum made the water cloudy, that substance was not present. The ammonia, therefore, obtained by distilling ordinary drinking-water with carbonate of sodium is not necessarily either "free" or "saline," but may be of the kind termed "albumenoid."

11. To ascertain how much of the ammonia of neutral ammoniacal salts which might be contained in drinking-water would be obtained by distillation with carbonate of sodium, as in the process described in "Water Analysis," I added 1·0 m.grm. of chloride of ammonium (=0·648 m.grms. of ammonia) to one litre of the same sample of water, then added 10 c.c. of a saturated solution of carbonate of sodium, perfectly free from ammonia, to half a litre of the mixture in a retort, and distilled over 50 c.c. and tested it. The distillate contained 0·25 m.grm. of ammonia, to which if one-third be added as directed in the book referred to† the result equals 0·666 m.grm. of ammonia per litre; =0·648 m.grm. from the sal-ammoniac, and 0·026 m.grm. (see paragraph 1) from the action of the alkaline carbonate upon nitrogenous matter. From this result it appeats that two-thirds of what may be termed the "saline" ammonia came over in the first tenth part of the distillate, as in the experiment where no alkaline

* Water prepared in this way was employed for making all the comparison tests liquid used in this investigation.

† I have generally found one-third too large a proportion to be added; I have also found the proportion variable.

carbonate was added (see paragraph 5). I further continued the distillation, throwing away the next 150 c.c. of distillate; then added 50 c.c. of a solution composed of 4 grammes of crystals of permanganate of potassium and 100 grammes of pure hydrate of potash, dissolved in pure water to form 500 c.c. by measure, the solution being perfectly free from ammonia, and distilled over three successive 50 c.c. and tested them; they yielded 0·083 m.grm. of ammonia, or 0·166 m.grm. per litre. The amount of ammonia obtained from the same sample by means of alkaline permanganate without addition of chloride of ammonium was 0·138 m.grm. per litre, as stated above.

12. To ascertain whether the amount of ammonia yielded by distillation of the ordinary water with the alkaline solution of permanganate only was less than the united amounts obtained by distillation with the carbonate and that solution in succession, I distilled half a litre of the sample with the permanganate only, and obtained exactly the same amount, viz., 0·164 m.grm. of ammonia per litre, as the united amounts obtained by distillation with the two substances (see paragraph 1). I also distilled a third similar quantity with the carbonate and permanganate solutions mixed together, and obtained nearly the same total amount of ammonia, viz., 0·156 m.grm. per litre. These and the previous results show that the carbonate of sodium may be dispensed with.

13. To determine whether the amount of ammonia obtained by distillation of the water with the caustic potash and permanganate of potassium solutions mixed together beforehand was less than if the potassic hydrate was used first, I took half a litre of the water, distilled 50 c.c., then added the 10 c.c. of carbonate of sodium solution, and distilled over 150 c.c., then added a solution (perfectly free from ammonia) of 10 grammes of pure hydrate of potassium in 50 c.c. of pure water to the residue in the retort, and distilled over three successive 50 c.c.; the two first of these gave a total of 0·028 m.grm. of ammonia per litre, and the third gave none. I now added 0·4 gramme of crystals of the permanganate, and distilled over three more 50 c.c. They gave respectively, after correction for a trace of ammonia contained in the permanganate, 0·146, 0·012, and 0·016 m.grm. of ammonia per litre. Rejecting the last of these because the liquid had become concentrated, the total amount of ammonia yielded by the potash and permanganate when separate was 0·186 m.grm. per litre, whilst it was only 0·138 m.grm. when those substances were mixed (see paragraph 1). This result shows that the mixture of those substances at the outset diminished their united yield of ammonia.

14. To ascertain whether the permanganate, in the state in which it was purchased, was free from ammonia, I added some to a solution of pure potassic hydrate, and distilled over 25 cc. The amount of ammonia found was about 0·01 m.grm. in 0·4 gramme of the salt.

15. In order to ascertain whether the method of analysing potable water by distilling it with carbonate of sodium and alkaline permanganate of potassium in succession converts into ammonia any portion of the urea which may be in the water, I dissolved 0·5 m.grm. of colourless, odourless, and dry crystals of urea (=0·283 m.grm. of ammonia) in half a litre of water, and distilled it with those substances in the usual manner, and obtained the following amounts of ammonia:—With carbonate of sodium, 0·0214 m.grm. per litre; with alkaline permanganate, 0·164 m.grm. per litre, = total 0·185 m.grm. per litre. The urea, therefore, did not increase the amount of ammonia obtained by distillation with carbonate of sodium. I also distilled a second half litre containing the same amount of urea, with the solution of alkaline permanganate only, and obtained 3·200 m.grm. of ammonia per litre. And I further distilled a third half litre of the same mixture of urea and water with the carbonate and alkaline permanganate solutions mixed together, and obtained 0·196 m.grm. of ammonia per litre. As the same sample of water without the addition of urea, distilled in the usual way, gave 0·026 m grm. of ammonia per litre, by distillation with the carbonate, and 0·138 m.grm. with the alkaline permanganate, equal to a total of 0·164 m.grm. per litre, the addition of the urea increased the total amount of ammonia from 0·164 m.grm. to 0·185 m.grm. per litre, or about 1-13·5 part of the total quantity of ammonia which the urea was capable of forming. If, therefore, ordinary drinking water contains 0·5 m.grm. of urea per litre, and is analysed by the process referred to, a small portion of the urea is converted into ammonia.

16. To ascertain whether a small quantity of urea in drinking-water is more completely converted into ammonia by distilling the water with the caustic potash and permanganate solutions separately than with them mixed together, I took half a litre of the water containing the same proportion of urea, distilled over 50 c.c., then added 10 c.c. of the carbonate of sodium solution and distilled over 100 c.c. Next added 50 c.c. of pure water, containing 10 grammes of pure potash, free from ammonia, distilled over three successive portions of 50 c.c. each, and obtained a total of 0·116 m.grm. of ammonia per litre. I then added 0·4 gramme of crystals of permanganate of potassium, and distilled over three more volumes of 50 c.c. each, and after correction for the small amount of ammonia in the permanganate, obtained 0·206 m.grm. of ammonia per litre. The total amount of ammonia obtained by distillation with the potash and permanganate separately was therefore = 0·322 m.grm. per litre, and included more than one-third of the total amount of ammonia which the urea was capable of yielding, whilst in the previous experiment with them mixed together it was only 0·185 m.grm. per litre, and included only about 1-13·5 part of the amount of ammonia the urea was capable of forming. Neither of these methods, therefore, shows the amount of urea in drinking-water.

17. By distilling over a further portion of 50 c.c., and two portions of 25 c.c. each, until the residue in the retort was only semi-fluid, 0·036, 0·160, and 0·200 m.grm. = a total of 0·396 m.grm. of additional ammonia per litre was obtained, shewing that a further amount of nitrogenous matter (besides that due in the present case to the portion of urea still undecomposed) remained in the water after stopping the distillation at the usual period in the process referred to.

18. I also took one-fourth of a litre of the same sample of water, added to it 25 c.c. of a solution, perfectly free from ammonia, of 100 grammes of pure potash in 500 grammes of pure water, and distilled over five successive portions of 50 c.c. each, and tested them. The first 50 c.c. gave 0·144 m.grm. of ammonia per litre, the second gave about 0·002, and the others none. I then transferred, by the aid of some pure water, the semi-fluid residue to a small tube retort of the annexed form, of thick refractory

glass, and evaporated it to perfect dryness, and heated it partly to redness; the tube then cracked. The distillate thus obtained gave about 0·32 m.grm. of ammonia per litre of the water, but the exact amount could not be determined because the colour produced on adding the test was a clear golden-yellow like that yielded by dilute aqueous methylamin. The total amount of "albumenoid" ammonia therefore obtained was about 0·466 m.grm. per litre, or 0·146 by distillation and 0·32 by ignition, whilst by the ordinary process of distillation only, as recommended in "Water Analysis," it was 0·164 m.grm. (see paragraph 1), or about one-third of that amount.

19. Although ignition greatly increased the yield of ammonia, it does not prove that the water was proportionately unwholesome. The nitrogenous compounds in river water are derived not only from animal substances but also from vegetable ones, such as vegetable albumen, legumin, casein, gluten, a great number of vegetable bases and bitter extracts, the green colouring-matter of leaves,

alkaloidal principles, &c., extracted or otherwise derived from living and dead plants of many kinds by the influence of rain, streams, and rivers; various observers have also found considerable quantities of "free" and "albumenoid" ammonia in rain-water collected in the atmosphere of the open country (see Dr. Angus Smith on "Air and Rain," pp. 235—286, &c.) Many different kinds of plants also when soaked in water yield a more or less different kind of nitrogenous organic matter. The ammonia, therefore, obtained from river-water, both by distillation with alkalies and by ignition of its residue, is probably derived from a considerable number and variety of nitrogenous compounds, some being noxious and others not so. As it is not yet clearly known which of these nitrogenous substances, especially when in such minute proportions, are unhealthful and which are not, it is probable that the albumenoid ammonia obtained by distillation with a strongly alkaline solution of permanganate, or the "organic nitrogen" obtained by a combustion analysis, affords a very inaccurate estimate of the unwholesomeness of water, because it is derived from and represents the harmless as well as the noxious nitrogenous ingredients. As also "albumenoid ammonia" and "organic nitrogen" are continually being carried to the earth by rain, it is certain that they do not afford a true measure of what is termed "previous or recent sewage contamination."

20. The sample of water operated upon in all these experiments was of a greenish colour when viewed through a depth of it equal to one metre. The colour was not due to salts of iron, but to vegetable matter; it was not affected by a drop of sulphide of ammonium, nor diminished by filtration, nor by addition of carbonate of sodium (which produced a cloud), and filtration, even if warmed or boiled after addition of that salt; but by adding a little alum (which also produced a cloud), and then filtering, the green colour was almost entirely removed. To ascertain, therefore, approximately, how much of the "albumenoid" ammonia capable of being obtained from the water was due to the green vegetable matter, I added 5 c.c. of a strong solution of chloride of aluminium to a litre of the water, then added 20 c.c. of the saturated solution of carbonate of sodium, allowed the precipitate to subside, and put half a litre of the perfectly clear liquid into the retort, and distilled it in the usual manner. The 200 c.c. of distillate obtained with the carbonate of sodium was disregarded, because the chloride of aluminium was found to contain a small quantity of ammonia (see paragraph 8). The distillate obtained with alkaline permanganate yielded 0·067 m.grm. of ammonia per litre of the water, or about one-half of that obtained when the green colouring matter was not previously removed (see paragraph 1). This diminution was not due to the alumina salt uniting with a salt of ammonia, because there was but little, if any, of the latter substance in the water (see paragraph 10). In consequence of these results I propose this method of using a salt of alumina in connection with Nessler's reagent as a means of determining approximately the amount of "albumenoid" ammonia derivable from the green vegetable colouring matter contained in samples of drinking-water.

21. After all liberation of ammonia by the alkaline permanganate in the foregoing experiment had ceased, the distillation was continued until the residue was of small bulk; the last 25 c.c. of distillate yielded 0·03 m.grm. of ammonia or 0·06 m.grm. per litre. The residue was then washed by the aid of pure water into a small glass bulb, distilled to dryness, and heated to redness; by these means 0·08 m.grm. more of ammonia per litre was obtained. The total yield of ammonia, therefore, by distillation and ignition with the alkaline permanganate, after precipitation of the green matter, was 0·207 m.grm. per litre (or 0·067 by distillation, and 0·14 by ignition), whilst in the immediately preceding experiment with caustic potash solution (see paragraph 18), and without previous precipitation of the vegetable colouring matter, it was 0·466 m.grm. per litre, or 0·146 by distillation and 0·32 by ignition. In each case also, whether the colouring matter was previously precipitated or not, the ignition yielded about twice as much ammonia as the distillation. As a solution of an acid salt of alumina perfectly free from ammonia was not readily obtained, I did not prosecute this part of the investigation farther.

22. In order to ascertain the effect on the yield of "free" and "albumenoid" ammonia of prolonged heating of the water previous to distillation, about two litres of ordinary town water was heated in a large carefully-cleaned flask, placed in a bath of water almost at the boiling point, a clean condensing apparatus being fitted in the mouth of the flask to prevent loss of vapour. Two experiments were made; in the first the water was heated during seven hours, and in the second during two. The following are the results expressed in parts per million:—

	Free ammonia.	Albumenoid ammonia.
Heated for seven hours ..	0·025 ..	0·160
,, two ,, ..	0·026 ..	0·160
Not previously heated ..	0·010 ..	0·130

23. From these results it will be seen that previously heating the water during two hours increased the yield of free ammonia by simple distillation without sodic carbonate about 2½ times, and of albumenoid ammonia about 1¼ times, but that the further heating of the water during five hours had scarcely any effect.

24. Every precaution having been taken to exclude extraneous impurities in these experiments, it is evident that the increase in the amount of ammonia after heating was due to oxidation of some of the organic matter (see paragraph 19). And as it was simply heating the water alone for a longer time which caused this result, the rate at which the ordinary process of distillation is conducted must to some extent influence the amount of ammonia obtained. Water thus treated would on analysis appear to be less pure, whilst in reality it would be more wholesome on account of the oxidation of some of its organic impurity.

25. The effect of prolonged agitation with air, upon the yield of ammonia by distillation with potassic permanganate was also ascertained. About 1 litre of water was continuously shaken during five hours in a closed bottle of 2½ litres capacity, and a portion of it analysed; the remainder was then similarly shaken during a second five hours, and also analysed. The following amounts of ammonia, in milligrammes per litre, were found:—

Water.	Free.	Albumenoid.	Total.
Not shaken	0·0050	0·140	0·145
Shaken five hours ..	0·0050	0·195	0·200
Shaken ten hours ..	0·0100	0·185	0·195

26. Similar and sufficient portions of the unshaken water, and of that which had been shaken, were evaporated to equally small bulks; the former was slightly the most alkaline.

27. These results indicate that, by the agitation, the nitrogenous matter in the water was so altered as to enable it to yield considerably more ammonia both by simple distillation without sodic carbonate and by the permanganate process. They also show that a sample of water which, by thorough contact with atmospheric air, is probably rendered more fit for drinking, might by the permanganate process be indicated as being less pure.

28. In order to ascertain whether the growth of vegetable matter in the water altered the proportion of ammonia or purified the water, another sample of the same town water was taken, a portion of it at once analysed for ammonia by the permanganate process, and the remainder exposed during eighteen days in a very large closed flask to the influence of sunlight, assisted by occasional gentle warmth, until the bottom of the glass became green with vegetable growth, and the amount of vegetable matter appeared to cease increasing; the amount of ammonia

in it was then determined. The following are the results:—

Water.	Free.	Albumenoid.	Total.
Unexposed	0·020	0·110	0·130
Exposed	0·030	0·130	0·160

29. From these results I conclude that the action of sunlight and warmth converted some of the nitrogenous matter into such a state that it yielded ammonia by simple distillation without sodic carbonate, and by the permanganate process; and by comparing them with previous results, that the effect in this respect was exactly the same as that of heating the water to a much higher temperature during two hours; and also similar to, but less in amount than, that of agitating the water in contact with air during five hours. Further, that the formation of vegetable growth caused the water to appear more impure when tested by the permanganate process, and that the nitrogen of the green vegetable matter was probably derived chiefly from impurities which would not yield ammonia by that process.

Conclusions and Summary of Results. — Returning to the retort, the distillate obtained with carbonate of sodium in the ordinary process of water analysis for ammonia and re-distilling it gave a slightly larger amount of "free" ammonia, and, mixing the alkaline carbonate with the sample of water twelve hours before distilling, gave a still larger increase. Permanganate of potassium solution, to which had been added pure caustic soda, acted apparently quite as well as that to which had been added hydrate of potassium.

Water containing even a very small amount of ammonia or its salts yielded much of its ammonia by simple distillation (see paragraphs 3 to 7), and did not require the aid of carbonate of sodium to liberate it unless salts of alumina were present (see paragraphs 8, 9, and 11). The production of ammonia by distillation with carbonate of sodium appeared to be due to the carbonate acting upon nitrogenous matter (see paragraph 10). Drinking water distilled with an alkaline solution of permanganate of potassium alone yielded as large a total quantity of ammonia as when previously distilled with sodic carbonate, or with a mixture of that substance and alkaline permanganate (see paragraph 12). Such water, distilled first with caustic potash and then with the permanganate alone, yielded more ammonia than when distilled with those two substances mixed together (see paragraph 13). Ordinary permanganate of potassium was found to contain ammonia (see paragraph 14). A very dilute solution of urea in the water was not converted into ammonia by distillation with carbonate of sodium, and only to a small extent by distillation with alkaline permanganate of potassium, and to about one-third only by distillation, first with caustic potash and then with permanganate (paragraphs 15 and 16). The residue left in the retort after the completion of the usual process of water analysis for ammonia yields a large additional amount of ammonia by heating to redness (paragraph 17); the usual permanganate process gave only about one-third (paragraph 18). Previous precipitation of the dissolved green vegetable matter in drinking water by means of salts of alumina diminished the amount of ammonia obtained by the subsequent distillation of the clear portion of the water with a solution of alkaline permanganate of potassium, and may be employed as a means of determining the approximate amount of ammonia due to such vegetable matter (paragraph 20). The effect of heating the water nearly to boiling (paragraph 22), or of exposing it to sunlight and warmth (paragraph 28), or of agitating it with atmospheric air (paragraph 25), and especially the latter, was to increase the proportions both of free and albumenoid ammonia yielded by the permanganate process, and whilst purifying the water render it apparently less pure according to this test.

If the object in water analysis is to obtain the largest amount of ammonia, it appears to be best effected by distilling the water first with a solution of caustic potash, then adding a solution of permanganate of potassium, distilling to dryness, and igniting the residue to redness.

CORRESPONDENCE.

DETERMINATION OF POTASH.

To the Editor of the Chemical News.

Sir,—A goodly number of samples of commercial muriate and sulphate of potash come under my notice, and recently a very serious discrepancy in my results as compared with those of a well-known Continental manufacturer came to light. This not only occurred once, but repeatedly, and strange to say the seller was the lowest. A sample testing 94·01 by seller's test, 95·8 and 95·9 by mine, was sent for control to a well-known analyst, whose potash determinations are a speciality. To my astonishment he returned it as containing 96·04 per cent, the mean of two determinations, and 95·87 as that of a third. It was quite manifest that there was some serious error vitiating our results, as it was very unlikely that a furnaced sulphate of potash which, in addition to the inevitable soda salts present, always contains very notable quantities of sulphuric acid as bisulphate, ferric sulphate, calcic and magnesic sulphate, &c., would contain 96 per cent potassic sulphate.

I first of all examined my reagents. The bichloride of platinum evaporated with the addition of HCl nearly to dryness, and alcohol added, remained perfectly clear. But on the addition of a little pure sulphuric acid a decided turbidity appeared. When filtered off, washed with platinum solution, then with alcohol, it presented the appearance of a white powder, not showing any appearance of the yellow potash precipitate under the microscope.

Another experiment was made in which the usual quantity of bichloride of platinum for a determination received a few grains of pure sodium sulphate, and was then evaporated on the water-bath, when a crystalline deposit gradually separated. This was washed twice with platinum solution, then with methylated spirit, precisely as in a potash determination, and dried. It weighed 0·2 grain, equal to 0·71 per cent of potassic sulphate, and was found to be calcic sulphate. Here I had at least a partial solution of the discrepancies. There can be no doubt that in the recovery of the platinum precipitates and washings, if reduced by alcohol in an alkaline solution (as is generally the case), it is very probable that the separation of lime in the after operations may be not quite complete, and this neglect may be aggravated by slight impurities in the acids sold as "pure."

It seems to me, at any rate, imperative that those who make potash determinations by this very accurate platinum method should satisfy themselves by evaporating a definite quantity of their platinum tetrachloride with a few drops of pure sulphuric acid, or sodic sulphate, nearly to dryness, dilute with alcohol, &c., and weigh any precipitate thus obtained. This weight ought to be deducted from that of every potash precipitate before calculating to percentage.

In recovering my platinum solutions and washings, I found it best to add a small quantity of pure sulphuric acid to the aqua regia used for dissolving the platinum, and, after evaporating tolerably low, dilute largely with pure spirits of wine. After standing some time, filter from the sediment, wash with alcohol, evaporate on the water-bath, add a little nitric acid to re-oxidise any reduced platinum tetrachloride, and so on.

Using this purified solution on a pure sulphate of potash (made by calcining cream of tartar, under neutralising with pure sulphuric acid, filtering, and crystallising), I obtained 99·93 per cent K_2SO_4, multiplying the weight of the precipitate by 0·35687.

Much has been written on the subject of the determina-

tion of potash in sulphates, and in order to convert the sulphate of potash into muriate the addition of chloride of sodium has even been recommended. I have never viewed this proposal with favour, introducing as it does a comparatively *large* quantity of fixed salts which have to be removed in solution in a *small* amount of solvent, in addition to the other impurities naturally present. My personal experience of it has quite corroborated my prepossessions, and, further, I have not found it at all necessary to revert to this method. My plan is to add a liberal excess of pure hydrochloric acid before evaporation, and a few drops after. As compared with the results of others, mine have not certainly come out too low.—I am, &c.,

KALIUM.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 12, September 22, 1884.

General Progress of Vegetation in Annual Plants: Amaranthaceæ.—MM. Berthelot and André.—The relative and absolute preponderance of lignine is shown more and more as vegetation increases, just as in borage. The soluble matters increase less rapidly, their proportion falling from equality to one-seventh. The albumenoids increase also in absolute weight, but their relative proportion reaches its maximum at the beginning of the time of flowering, and then diminishes greatly. The salts of potash which represent the organic acids and nitric acid, and consequently the phenomena of oxidation, increase continually in absolute weight. Their relative maximum coincides with that of the soluble principles and the albumenoids at the beginning of inflorescence.

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 3, August 5, 1884.

Action of Phosphorus Perchloride upon the Aromatic Ethers.—A. Colson.—Not adapted for abstraction.

On Various Colloids.—E. Grimaux.—The author's researches extend to Schweitzer's liquid, the condensed pyruvic ureides, the amido-aspartic colloid, and soluble silica.

On Prophenyl-glycolic Acid.—C. A. Lobry de Bruyn.—This acid consists of $CH_2CH=CHCHOH.COOH$.

Action of Hydrocyanic Acid and Dilute Sulphuric Acid upon Aldol.—C. A. Lobry de Bruyn.—The product obtained is cyanhydrine, formed of two mols. of aldol and 1 mol. of hydrocyanic acid.

Detection of Coal-Tar Products in Wines by means of Amylic Alcohol and Ammonia.—M. Jay.—The author adds to 100 c.c. of the suspected wine 2 or 3 c.c. of ammonia, and then 3 to 4 c.c. of amylic alcohol. After shaking up the amylic alcohol floats on the top, taking a rose colour more or less distinct if a foreign colouring matter is present. If the colour is indistinct the amylic alcohol is decanted off, and evaporated in contact with a small piece of white silk, which takes up the colour.

Action of Tellurous and Telluric Acids upon the Paratungstates.—D. Klein.—The action of tellurous acid upon the paratungstates gives rise not to well crystallised salts, but to pulverulent deposits in which the presence of tellurous and telluric acids seems marked. By the action of telluric acid there is produced a crystalline compound containing potassium and the tungstic and telluric acids.

Substance Employed in Spain for Colouring Wines (Tintura por los Vinos).—M. Jay.—This colour is composed of Biebrich red, a smaller quantity of a red of the rosaniline group, and arsenious acid to the extent of 1·62 per cent!

Action of Benzoyl Chloride upon Isodurol in Presence of Aluminium Chloride.—MM. Essner and Gorsin.—The principal product obtained is benzoyl-isodurol.

Potassium and Barium Glyoxal Bisulphites.—M. de Forcrand.—Not adapted for useful abridgment.

Decomposition of Pyridic Ammonium Iodides by the Alkalies.—Oechsner de Coninck.—The author has studied certain new colouring-matters resulting from this reaction, derived from β-lutidine, from α and β-collidine (obtained from brucine and cinchonine), from α-picoline and γ-lutidine (of coal tar).

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome xi., June, 1884.

Report on M. Clemandot's Process for Tempering Steel by Compression.—Ad. Carnot.—The process consists in heating the metal to make it acquire a sufficient ductility, and submitting it during cooling to very energetic pressure.

Revue Universelle des Mines, de la Metallurgie, &c.,
July and August, 1884.

Analysis of the Copper Ore of Stolzembourg, in the Grand Duchy of Luxemburg.—This ore, a copper pyrites, contains 28·5 per cent of copper and 34·3 of sulphur, and is free from arsenic and antimony.

Cosmos les Mondes.
No. 18, August 30, 1884.

This issue contains no chemical matter.

No. 1, September 11, 1884.

A paragraph here inserted states that the poisonous properties of the aniline colours do not, as commonly supposed, depend on the presence of arsenical compounds. According to MM. Poincarré and Nassias, they are dangerous even in a state of absolute purity. The least dangerous of all is magenta. [This opinion does not agree with the prolonged observations of Dr. Grandhomme, conducted at the Works of Meister, Lucius, and Brüning.]

No. 2, September 18, 1884.

The quantity of domestic refuse produced at Paris is about 2500 cubic metres daily, whilst the sewage amounts to 300,000 metres daily.

Death by Electricity.—Dr. Gariel has just published in the *Electricien* a report on the death of two young men who were killed as far back as August 6, 1882, by having incautiously or accidentally touched with both hands one of the wires conveying an alternating current of about 500 volts to supply 12 Siemens lamps in the gardens of the Tuilleries. The immediate cause of death seems to have been stoppage of the action of the heart.

No. 3, September 27, 1884.

This number contains no chemical matter.

Journal de Pharmacie et de Chemie.
Series 5, Vol. ix., May, 1884.

Characters distinguishing Chloroform and Methylene Chloride from a Physiological Point of View.—MM. J. Regnauld and Villejean.—This paper has no chemical bearing.

Extemporaneous Gelatinous Calcium Phosphate.—C. Tanret.—A pharmaceutical memoir.

Powders of Meat.—M. Yvon.—Thoroughly cooked meat, when sufficiently comminuted, is as readily attacked by the gastric secretions as raw meat.

Observations on the Tincture of Iodine.—A. Lambert.—A solution of iodine in methylated alcohol gives off a volatile product of an odour resembling that of acrolein. This reaction is due to the presence of acetone, which forms with the iodine an iodised acetone and acrolein.

On Digestive Ferments and their Pharmaceutical Preparation.—M. Pierre Vigier.—A purely pharmaceutical paper.

New Reactions characteristic of Codeine and of Esculine.—L. Raby.—To the codeine placed in a watch-glass are added two drops of the common solution of chloride of soda, the alkaloid is stirred up, and four drops of undiluted sulphuric acid are added. The whole is then mixed up with a glass rod, when there appears a splendid and persistent blue colouration. If bromine water is substituted for chloride of soda, this colouration does not appear. Bromine water, if used alone, becomes turbid in contact with codeine. On stirring, the liquid clears up and becomes perfectly colourless, but after a few seconds there appears a violet colouration, not very intense, but quite distinct. On experimenting with some thirty of the commonest alkaloids, the author obtained in no instance a colour which could be mistaken for the fine blue above mentioned. On the other hand, chloride of soda and strong sulphuric acid—if applied in a slightly different manner—give a fine violet colour with esculine. The author adds to the esculine four drops of sulphuric acid: to the slightly coloured liquid resulting from this mixture there is added gradually a solution of chloride of soda, stirring continually. When sufficient has been added the liquid takes an intense violet colour, which fades gradually, and disappears entirely in about an hour. On operating in an inverse manner the colouration is not obtained. If bromine water is substituted for chloride of soda there is formed a precipitate of the colour of dregs of wine: this reaction is less fine and less certain than that with chloride of soda.

Preparation of Pure Hydrochloric Acid.—M. Giudice.—The sulphuric acid employed is mixed with a small quantity of potassium permanganate, and the hydrochloric gas before being absorbed in water is passed into a bulb-tube containing mercury. The permanganate prevents the formation of sulphurous acid, and the mercury absorbs free chlorine and decomposes arsenic chloride.

Purification of Hydrochloric Acid.—M. Bensemann.—The commercial acid may be obtained free from arsenic and sulphurous acid if it is diluted to 1·12 sp. gr., and distilled over a little potassium chlorate.

Antimony Penta-Iodide.—M. Pendleton.—From the Chemical News.

Sodium Hypobromite as Reagent for Gum-Ammoniac.—P. C. Plugge.—Sodium hypobromite produces a fine reddish violet colouration in an alkaline solution of gum-ammoniac. Plugge dissolves 30 grms. sodium hydroxide in distilled water, adds 20 grms. bromine and makes up to 1 litre. A few drops of this reagent added to an ethereal solution of the gum-resin give the reaction immediately.

On Carvol.—A. Beyer.—The carvols obtained from carraway and from aniseed resemble each other exceedingly in their optical properties. That of *Mentha crispa* deflects the plane of polarisation to the left as much as the other carvols turn it to the right.

Glucoside from Viola arvensis.—K. Mandelin,—The alcoholic extract of *Viola tricolor* (variety *arvensis*) is taken up in water and shaken with benzol to remove salicylic acid. The aqueous solution deposits light yellow crystalline needles, violaquercitrin, $C_{84}H_{42}O_{48}$. This compound, on treatment with dilute mineral acids, is split up into quercitrin and a fermentable sugar.

Researches on Solubility.—Edmond Dupuy.—The author recommends that the sample of the solution for analysis should be taken very rapidly, as it may otherwise suffer less from crystallisation or evaporation.

June, 1884.

Scale of Temperatures, and on Molecular Weights.—M. Berthelot.—Already noticed.

The Digestive Ferments and their Pharmaceutical Preparations.—Pierre Vigier.—This paper is of no chemical interest.

Note on Abrus precatorius.—G. Patein.—An examination of the state in which iron occurs in the seeds of this plant.

Sophistication of Flour.—M. Balland.—A hydrated calcium sulphate in fine powder has lately been offered to millers for mixing with flour in the proportions of 1 to 1·5 per cent. If the weight of the ash of a flour decidedly exceeds 0·6 per cent the analyst should determine lime and sulphuric acid. In a genuine flour there is very little lime and a mere trace of sulphuric acid.

Officinal Mercuric Oxides.—P. Carles.—A pharmaceutical paper.

Gum of Grevillea Robusta.—M. G. Fleury.—This gum, which is now produced in Algeria, closely resembles gum-arabic in its reactions.

Titration of Cinchonas.—M. Huguet.—The author approves of the process of Prollius Petit, but points out that the powder of the sample operated upon should be equally fine in every case. Heat should be avoided as much as possible during the process of extraction. The rotatory power of the mixed alkaloids should be determined, and then that of the crystalline quinine sulphate.

Production of Zinc Formiate in Cisterns containing Oil of Turpentine.—M. Schlagdenhauffen.—The sides of the zinc cistern were coated with a deposit of zinc formiate. Lead formiate has been formerly discovered in lead cisterns used for the same purpose.

The Tannin of Alder Bark.—M. Lamasse.—The amount of tannin in this bark has been very variously estimated at from 3 to 20 per cent. The tannin in question belongs to the same series as that of the oak, being a methyl-tannin. With ferrous acetate it gives a reddish-blue precipitate; with ferrous sulphate an olive-green; it is precipitated by solution of gum, but is not affected by tartar emetic.

Reaction of Gallic Acid.—S. Young.—If a solution of gallic acid is shaken up with a solution of potassium cyanide there is produced a fine red colour, which disappears on standing. If the liquid is shaken up the redness reappears in the entire mass of the liquid, but is permanent only on the surface if the mixture is left at rest. In this manner the red colour may be made to appear and disappear for fifteen to twenty times in succession. Finally the liquid becomes of a permanent brown. In this manner gallic acid may be detected in the tannins of commerce.

New Reaction of Atropine and of the Mydriatic Alkaloids.—A. W. Gerrard.—From the *Pharmaceutical Journal*.

New Reaction for Distinguishing Nepaline from Aconitine.—M. Mandelin.—These two bodies behave in a different manner with nitric acid and with an alcoholic solution of potassa. If nepaline is evaporated with a few drops of fuming nitric acid we obtain a residue with an odour of musk, which when brought in contact with a few drops of a solution of potassium hydroxide in absolute alcohol produces a carmine or purple colour. Aconitine behaves quite differently. This reaction is still distinctly appreciable with 0·01 of nepaline.

July, 1884.

Dissociation, appreciated by J. B. Dumas.—A portion of the éloge of H. Sainte-Claire Deville read by M. Bertrand after the death of the author.

Analysis of the Oily Seeds of Symphonia Fasciculata.—MM. J. Regnauld and Villejean.—The proportion of the fatty principles in this seed is 56 per cent. They contain no substance capable of modifying their bland flavour, and they are further remarkable from the nature of their glycerides, which render them strikingly analogous to the fats of mammalian animals used as food. The stringent matters isolated closely resemble the principles of the same kind found in the cinchonas.

Digestive Ferments and their Pharmaceutical Preparations.—Pierre Vigier.—Continued from the last number.

A Geological and Hydrological Study of the Valley of the Agly (Eastern Pyrenees).—J. L. Soubeiran.—A notice of the general character of the potable waters of the district.

Remarks on the Determination of the Alkaloids by the Optical Method.—G. Fleury.—The author contends that an exact analysis cannot be made of mixtures, *e.g.*, of quinine and quinidine. When these salts are mixed in water they influence each other mutually, as experiment proves. The difficulty of always operating at +17° is a further argument against using polarising apparatus in quantitative analysis.

Studies on Conrallaria Maialis.—A. Langlebert.—A pharmaceutical paper.

Mineral Springs of Bourbon-l'Archambault.—E. Willm.—This paper may possibly have some medical interest.

Aseptol, a Soluble Substitute for Phenic and Salicylic Acids.—M. Annessens.—Aseptol or orthoxy-phenylsulphurous acid, $C_6H_4,OH,(SO_2OH_2)$, is an energetic acid, perfectly soluble in water. It is said to possess the same anti-putrescent powers as salicylic acid, but to be free from irritant or poisonous properties.

The Physiological and Therapeutic Action of Cotoine.—M. Albertoni.—This paper has no chemical interest.

On Vanillism.—Dr. A. Layet.—An account of certain morbid symptoms with which persons who work with vanilla are liable to be affected.

Coal-Gas and Carbon Monoxide.—Dr. E. Richard.—The author discusses the dangers due to an escape of coal-gas from the mains through the soil. The poisonous effects of carbon monoxide are very distinct at 0·4 per cent. Exposure to such a mixture is fatal in from thirty to sixty minutes. As coal-gas contains about 10 per cent of carbon monoxide the presence of such gas in the proportion of 4 to 6 per cent will become fatal. When coal-gas traverses a layer of soil before entering a house the danger is greatest, since it is then deodorised and its presence may remain undetected.

Manufacture of Wood-Pulp by means of Sulphurous Acid at a Low Temperature.—Raoul Pictet.—The author treats the comminuted wood or other vegetable matter with concentrated solution of sulphurous acid and water under a pressure of 5 atmospheres and at temperatures ranging from 75° to 80°.

——

Justus Liebig's Annalen der Chemie, Vol. 224, Part 3.

Communications from the Chemical Laboratory of the Technical High School of Stuttgart.—These consist of a paper of Fr. Nafzger on the acids of bees-wax. In the portion of wax which is soluble in alcohol—cerine—the anther finds cerotic acid. In myricine, the portion insoluble in alcohol, there occur palmitic acid and an oleic acid which the author did not succeed in obtaining in a state of purity.

Comparative Researches on the Methods of Fractionated Distillation.—Dr. Hans Kreis.—The author remarks that the apparatus for fractionated distillation on the large scale is far more perfect and satisfactory than that for laboratory experiments, where the entire quantity to be operated upon does not exceed 50 grms. He gives the preference to Hempel's tube, filled with glass beads, which is figured in the original.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir by Dr. Oscar Frœlich on the products formed on treating bromine with nitric oxide gas, and a paper by Professor A. Geuther on a new phosphoric ether.

Communication from the Central Chemical Laboratory of the University of Tubingen.—This is a memoir by Paul Spindler on the nitration of the benzol derivatives, which does not admit of useful abstraction.

Communications from the Laboratory of the University of Halle.—These include a paper by G. Baumert on the action of acetyl chloride and acetic anhydride upon lupinine, in which the author proves the existence in that base of two hydroxyl groups of an alcoholic character. Another paper by the same author treats of the liquid alkaloid of *Lupinus luteus*.

Action of Dimethyl-para-toluidine and Dimethyl-aniline upon Ethylen Bromide.—H. Hübner, A. Tölle, and W. Athenstadt.—This paper does not admit of useful abstraction.

Action of Ferric Chloride upon Ortho-phenylen-diamine.—F. Wiesinger.—The product, a salt crystallising in long needles of a ruby-red colour, is the hydrochlorate of a new base.

TO CORRESPONDENTS.

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THE CHEMICAL NEWS.

Vol. L. No. 1300.

ON A

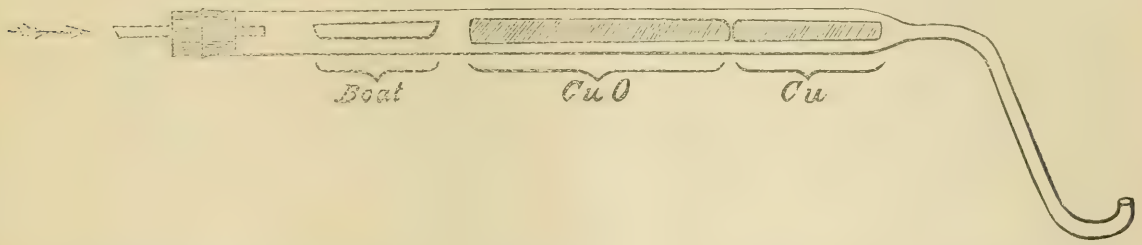
MODIFICATION OF DUMAS'S METHOD FOR THE QUANTITATIVE ESTIMATION OF NITROGEN.

By G. STILLINGFLEET JOHNSON.

Having occasion recently to make a complete quantitative analysis of the platinum salt of a nitrogenous base, I was desirous of securing as many platinum determinations as possible, and my efforts to economise the samples of substance employed for nitrogen determinations for this purpose resulted in the following process, which may prove serviceable to others.

A long combustion-tube is selected, and drawn out at one extremity in the form shown in the figure. Freshly reduced metallic copper is packed into the front of the tube as usual; behind this is a layer of cupric oxide, preferably granulated oxide; whilst at the extreme back of the tube a porcelain boat, which may be from 4 to 5 inches in length, is introduced. The front half of this boat contains the substance to be analysed, whilst the remainder is filled with pure *potassium chlorate*, which has been previously just fused and then powdered. If the operator deems it advisable the chlorate may be separated from the substance by a small plug of ignited asbestos.

The analysis is conducted as follows:—Air is expelled from the *cold* apparatus by a stream of pure carbon dioxide, which is best delivered from a Kipp's constant-generating apparatus.



After the CO_2 has been passed in the cold for about ten minutes, heat is applied to the whole of the front part of the tube, which is laid upon the combustion-furnace, up to within an inch of the boat containing the substance, the operator taking the usual precautions to avoid overheating of the tube and its contents in the immediate neighbourhood of the boat.

The front part of the tube having been kept at a low red-heat whilst the CO_2 has been continuously passing through it for a quarter of an hour, a sample of the gas is collected as it issues from the tube, by displacement of water or mercury in the usual way, and on examination is usually found to be perfectly free from nitrogen. If anything of consequence remains unabsorbed by strong solution of potash the process is continued till the issuing gas is pure carbon dioxide.

When complete expulsion of nitrogen from the ignited copper oxide has been ensured the receiving apparatus for the nitrogen of the substance under analysis is adjusted according to the taste of the operator. I have myself employed with much advantage Dumas's original apparatus,—a mercurial trough and a graduated glass tube about one-third full of strong potash solution, and the remaining two-thirds containing mercury.

The receiving apparatus for the nitrogen of the substance under analysis having been duly arranged so that the drawn out extremity of the combustion-tube fits under the open extremity of the graduated gas tube, the heat is gradually extended backwards towards the porcelain boat, a slow stream of carbon dioxide being still kept passing. It will be found very easy to effect a slow destructive distillation of the substance by means of hot tiles, &c., without bringing about any expulsion of oxygen from the potassium chlorate. As soon as the evolution of nitrogen, which results from the destructive distillation of the substance, has ceased, as shown by the volume of permanent gas above the caustic potash in the receiving-tube remaining unaltered, the heat is allowed to spread to the further extremity of the boat, which contains the potassium chlorate. Evolution of oxygen gas of course follows, during which the stream of CO_2 may be somewhat slowed. The more or less nitrogenous charcoal left in the boat is now rapidly consumed, and an addition is made to the volume of the gas in the receiving-tube.

The remainder of the analysis is simple. The passage of the CO_2 is continued as long as any permanent gas escapes absorption by the potash, and the volume of the nitrogen is then read as usual.

The advantages of the process I have described are as follows:—

1. The expulsion of air from the copper oxide is certainly more rapidly, and probably more completely, effected at a red-heat than it is at the ordinary temperature by a stream of CO_2.
2. In burning platinum, gold, or silver salts, these metals are retained in the boat, and may be weighed after simply washing out the potassium chloride adhering to them.
3. Much valuable insight into the constitution of nitrogenous compounds may be gained by observing the ratio between the volume of nitrogen gas expelled during what I may call the first stage of the analysis, or the stage of destructive distillation in an atmosphere of CO_2, and that which escapes during the second stage, *i.e.*, the stage of combustion of nitrogenous charcoal in oxygen gas.

This is thrown out as a hint to future observers, but I may state, in illustration of the possible importance of the data which may be obtained, that the ratio of nitrogen in stage one to N of stage two in the case of an organic base was as 1 to 3, whilst in the case of a cyanogen compound it was as 6 to 1.

If any doubt be entertained as to the efficacy of the metallic copper in front of the tube in absorbing excess of oxygen gas from the chlorate of potash, the measured nitrogen may be shaken up with a little solution of alkaline pyrogalline and again measured.

King's College, London.
Oct. 12, 1884.

The Decomposition of Benzo-nitrile by means of Fuming Sulphuric Acid.—Fr. Gumpert criticises the researches of Pinner and Klein, and regards their dibenzimido-oxide and benzimido-benzoate respectively as benzimido-benzamide and dibenzamide.—*Journal fur Praktische Chemie.*

RESULTS OF SOME EXAMINATIONS OF BUTTER.

By HENRY LEFFMANN, M.D.

I SUBMIT the following as an example of the quality of the butter sold in Philadelphia, the samples having been purchased at random in the course of an investigation for the Pennsylvania State Board of Agriculture. I tried various methods of analysis, and finally fixed on that in which the amount of alkali necessary to saponify the fat is determined. Just as the work was completed I saw a notice of Mr. Wanklyn's suggestion that when true butter is heated with alcoholic soda butyric ether is given off. I tried this test on all of the samples, and, as will be seen, it gives good results. In the table subjoined the term "acid equiv." refers to the amount of standard acid to which 1 gramme of the fat is equivalent in action on alkali; the column "Odour with Alcoholic Soda" shows the effect with Wanklyn's test. As matters of some interets I give the price per pound, the title under which the article was sold, and a judgment based on the analytical results.

Nos. 1, 18, and 19 were known to be genuine; No. 20 was sent by a friend; No. 21 is a sample of tallow introduced for comparison. The figures obtained show that the saponification process is very satisfactory.

No.	Price per pound.	Acid Equivalent.	Odour with Alcoholic Soda.	Name by which Sold.	Probable Character.
1	35 cents	5·5	Present	Dairy Butter	Genuine
2	35 cents	4·9	Absent	No title	Bogus
3	35 cents	5·7	Present	York State Creamery	Genuine
4	30 cents	5·1	Indistinct	Royal Creamery	Doubtful
5	25 cents	5·0	Indistinct	Roll Butter	Doubtful
6	45 cents	5·8	Present	Best Creamery	Genuine
7	25 cents	4·7	Indistinct	Farmer's Dairy	Bogus
8	45 cents	6·3	Present	Skippack Creamery	Genuine
9	40 cents	5·6	Present	Perkiomen Dairy	Genuine
10	40 cents	5·9	Present	Creamery	Genuine
11	27 cents	4·8	Indistinct	Suine	Bogus
12	30 cents	5·0	Indistinct	Oak Lane Creamery	Doubtful
13	32 cents	4·8	Indistinct	Roll Butter	Bogus
14	25 cents	4·6	Indistinct	Butterine	Bogus
15	30 cents	6·0	Present	Farmer's Dairy	Genuine
16	35 cents	6·0	Present	Chester Co. Creamery	Genuine
17	25 cents	5·0	Indistinct	Roll Butter	Doubtful
18	—	5·8	Present	———	Genuine
19	—	5·6	Present	Pure Jersey Butter	Genuine
20	—	4·6	Absent	———	Bogus
21	—	4·3	Absent	Sample of Tallow	

THE RAPID DETERMINATION OF FIXED AMMONIA.

By J. W. PRATT, F.C.S.

WHEN free and combined ammonia exist together in the same solution the former is usually estimated by direct titration and the latter by distillation with caustic alkali and absorption in acid, also of known strength. The difference between the first and the latter result is set down as fixed or non-volatile ammonia as distinguished from the carbonates, sulphides, &c., of ammonia which neutralise acid and are volatilised on boiling.

The process of distillation for the determination of the fixed or total ammonia is often very troublesome, owing to the frothing caused by the action of the alkali on organic matter present, and requires frequently a large amount of time and attention for its successful accomplishment. For this and other reasons, where a large number of determinations of free and fixed ammonia have to be performed daily, the distillation process becomes specially inapplicable. Being placed in such a position some shorter method became necessary, and the volumetric method of boiling the ammoniacal liquid with a definite volume of alkaline solution and titrating the residual alkali naturally suggested itself. This method, which I have used for some considerable time, gives results closely agreeing and often identical with those obtained by distillation, but with a much smaller expenditure of time and attention. It is well suited for the testing of gas water and bone-liquor, which are nearly constant in constitution if not in percentage composition. The alkaline solution used for the boiling off of the total ammonia is a decinormal one of carbonate of soda. Sodic carbonate I find more suitable than the hydrate (which has been recommended), as caustic soda is apt to form with the ammonic sulphide sometimes present sodic sulphide, which gets oxidised to sulphate and so yields a slightly too high result.

The following examples out of many will serve to show how the method is carried out and agrees with the distillation process:—

(1.) 5 c.c. bone-liquor distilled with caustic soda into 50 c.c. normal HCl solution neutralised 25·5 c.c.

$25{\cdot}5 \times 20 \times 0{\cdot}017 = 8{\cdot}67$ per cent total ammonia.

5 c.c. same liquor titrated with normal HCl and methyl-orange indicator = 25 c.c. normal acid.

$25 \times 20 \times 0{\cdot}017 = 8{\cdot}5$ per cent free ammonia.

25 c.c. of liquor boiled and evaporated to dryness with 25 c.c. N/10th Na_2CO_3, ignited to get rid of organic matter, and treated with water. The solution took 3·2 c.c. normal HCl for neutralisation = 16 c.c. N/10th Na_2CO_3.

25 c.c. − 16 c.c. = 9 c.c. N/10th Na_2CO_3 consumed.

$9 \times 4 \times 0{\cdot}0034 = 0{\cdot}1224$ per cent fixed ammonia.

Adding to this amount of ammonia the amount found by direct titration (8·5 per cent) we have 8·6224 per cent, as against 8·67 NH_3 obtained by distillation.

(2.) 50 c.c. gas-water distilled with NaHO solution neutralised 39·2 c.c. normal HCl.

$39{\cdot}2 \times 2 \times 0{\cdot}017 = 1{\cdot}3328$ per cent total NH_3.

50 c.c. same sample titrated directly with normal HCl = 32·1 c.c. HCl.

$32{\cdot}1 \times 2 \times 0{\cdot}017 = 1{\cdot}0914$ per cent free NH_3.

25 c.c. evaporated to dryness with 25 c.c. N/10th Na_2CO_3 taken up with water and titrated required 1·5 c.c. normal HCl = 7·5 c.c. N/10th Na_2CO_3 solution.

25 c.c. − 7·5 c.c. = 17·5 c.c. N/10th Na_2CO_3 consumed.

$17{\cdot}5 \times 4 \times 0{\cdot}0034 = 0{\cdot}2380$ fixed NH_3.

Adding to amount of free ammonia (1·0914 per cent) the fixed ammonia as above, 0·2380 per cent NH_3, we have

1·3294 per cent total ammonia, as compared with 1·3328 per cent total NH_3 by distillation.

It is well before applying this method to test the reaction of the sample to litmus-paper before and after boiling a small portion of it. If the liquor remains alkaline after expulsion of the ammonia by boiling it is obvious the method is not suitable without such correction or modification as may be left to the discrimination of the analyst.

A NOTE ON SOME PHYSIOLOGICAL EXPERIMENTS WITH IRON SULPHATE ON PLANTS.

By Dr. A. B. GRIFFITHS, F.C.S.,
Membre de la Société Chimique de Paris, Lecturer on Chemistry and Physics, Technical College, Manchester, &c.

Concerning the researches I have been engaged upon for the last three years on the use of ferrous sulphate as a manure for certain plants, I am desirous of informing chemists that I have found when plants are grown with this manure an excess of it is injurious, as I have shown in my paper (Chemical News, vol. l., p. 167, and *Chemiker-Zeitung*, 1884, p. 757) on this subject. But, further than this, all my researches on iron as a manure go to show that when the amount of *ferric oxide* in the ashes of all the plants I have grown with this new manure has reached 10 per cent the plant died. So it is quite impossible for the plants I have examined in these researches to live when any one of them is capable of yielding after incineration *ten per cent* of Fe_2O_3 in their ashes.

I intend next month to present a long memoir to the Chemical Society detailing some important results on the subject.

ON THE COLOUR OF CHEMICAL COMPOUNDS REGARDED PRINCIPALLY AS A FUNCTION OF THE ATOMIC WEIGHTS OF THEIR CONSTITUENT ELEMENTS.

By THOMAS CARNELLEY.

The colour of chemical compounds depends on at least three conditions, *i.e.* (1) the temperature; (2) the quantity of the electro-negative element; and (3) the atomic weights of the constituent elements.

Of these three conditions the two former have been especially studied by Mr. Ackroyd (Chemical News, vol. xxxiv., p. 76). The author therefore wishes to direct attention mainly to the third point. He gives, however, a brief summary of Mr. Ackroyd's results concerning the two former conditions.

1. All the chrome compounds change their colour in a definite serial order, and indeed in that of the spectral colours, in such a manner that as the temperature rises the colour approximates more and more to the red end of the spectrum, and ultimately, at a sufficiently high temperature passes into brown and black. Most frequently the transition of colour is direct from white to a pale yellow, whilst violet, indigo, blue, and green are passed over as transition stages.

2. In binary compounds an increase of the quantity of the electro-negative element involves a change of colour to the red end of the spectrum, and ultimately into brown and black. Thus PbO is yellow, Pb_2O_4 red, and PbO_2 brown.

3. Influence of the atomic weight: in some series of compounds, A_x, R_y; B_x, R_y; C_x, R_y; &c., in which R is an element or a group of elements, whilst A, B, C, &c., signify elements belonging to the same subordinate group in Mendeleeff's table of the natural classification of the elements, the colour passes either entirely or partially through the following scale:—White or colourless, violet, indigo, blue, green, yellow, orange, red, brown, black, with the increasing atomic weight of the elements A, B, C, &c. Or, in other words, the higher the atomic weight of the elements A, B, C rises, the more the colour of the compound approaches the red end of the spectrum, and passes in certain cases into brown and black.

It must be remarked that the above rule applies only to cases in which A, B, C, &c., are elements belonging to the same sub-group, but not to cases in which they belong to different sub-groups. Thus, oxides cannot be directly compared with the corresponding sulphides, selenides, and tellurides; in like manner fluorides cannot be compared with the corresponding chlorides, bromides, and iodides, since fluorine and oxygen belong to even series, whilst chlorine, bromine, iodine and sulphur, selenium, and tellurium belong to odd series. The author then gives tables showing the influence of the atomic weight on the colour of the compounds.

In these tables the colours of every compound is given as laid down in the usual manuals. If two authorities state different colours both are mentioned. Some compounds exist in two allotropic conditions of different colours: in this case both colours are quoted. It must not be forgotten that the above rule applies in strictness only to compounds in the solid state; and, further, that the colour in the solid state may, to a certain extent, change in accordance with the state of aggregation.

Besides the 426 cases in which the author found the above rule applicable, there appeared 14 exceptions.

Four of these, $DiCl_3$, V_2O_3, CrO_3, and CdO, do not admit of any satisfactory explanation.

Theoretic Explanation.

In the discovery of the following explanation of the phenomenon in question the author acknowledges the assistance received from his colleague Mr. J. W. Capstick.

1. *Influence of the Atomic Weight* (*a*).—In a solid body the molecules vibrate as entireties in certain mean positions. If the conditions are in other respects alike (*e.g.*, the temperature) the period of vibration will be the smaller the less dense the mass of the molecule. If the time of the vibration of the molecules is so small that it coincides with any vibration beyond the violet end of the spectrum no visible vibration can be absorbed and the colour must appear white. This condition must persist until (by chemical substitutions, &c.) the molecular mass becomes so large that its period of vibration falls above the violet extremity, when the violet rays are absorbed, and the compound appears of the complementary colour of violet, *i.e.*, greenish yellow. If the mass of the molecule becomes still greater, the period of their vibrations increases more and more, and the blue rays begin to be absorbed, whilst the unabsorbed light is yellow. Next the green rays are absorbed, and the result is orange. Then the yellow is extinguished, leaving only red. Finally the red is absorbed, and the substance becomes black.

(*b*.) If we may conclude from the observation of colours it seems an almost invariable rule that in case the period of vibration is long enough to extinguish any given colour it annihilates all those colours which have a shorter wavelength; thus if yellow is extinguished blue and green disappear also. Otherwise, the colours would pass from orange to a purple-red; and if red were obliterated without the simultaneous disappearance of blue, green, and yellow, the colour would appear greenish instead of the ordinary black. The exceptional green colour of Au_2O, AuI_3, WCl_4, WI_2, UCl_5, and UCl_4 may thus be explained.

2. *Influence of Temperature.*—In case of a solid body in which the molecules vibrate in certain mean positions, an increase of temperature occasions a greater amplitude of vibration, but not a longer period. In connection herewith a rise of temperature diminishes the cohesion between the molecules and thus enfeebles the power of recuperation, since the molecules are thus induced to vibrate more

slowly and thus to bring about the same changes of colour which were observed as the mass of the molecules increases.—The above theory seems to me a satisfactory explanation of the otherwise paradoxical fact that an increase of molecular weight on the one hand, and on the other a rise of temperature, should occasion exactly the same changes of colour.

That in certain binary compounds an increase of the proportion of the electro-negative element occasions a change of colour towards the red extremity of the spectrum may probably be due to the circumstance that with an increased quantity of the electro-negative element an increase of the molecular weight follows. The phenomenon may then be readily explained by the theory given above. However, to render this explanation universally available it would be necessary in certain cases, *e.g.* the oxides of copper, lead, and chrome to double or treble the generally received formulæ for some of their grades of combination. Thus :—

Cu_2O, red ; Cu_2O_2, black.
PbO or Pb_3O_3, yellow; Pb_3O_4, red ; Pb_3O_6, brown.
Cr_2O_3, green ; Cr_2O_6, red.

Lastly, there appear certain indications that the colour of compounds is a periodic function of their atomic weights. This is best seen if we consider the normal iodides. If we construct a curve in which the ordinates represent the atomic weights of the positive elements and the abscissæ a scale of colours rising from black through brown, red, orange, yellow, green, &c., up to white, the curve resembles in form Lothar Meyer's well-known curve of the elements.

The author purposes extending his researches to the colours of organic compounds.—*Berichte der Deutschen Chemischen Gesellschaft.*

DECOMPOSITION AND ANALYSIS OF SLAGS.

By MALVERN W. ILES, Ph.D.

Several years ago, in the columns of the *Engineering and Mining Journal* (vol. xxxi., p. 58), I described a method for the decomposition of slags, for analytical purposes. This method, briefly stated, was to fuse the finely-powdered slag with caustic potash in a silver crucible.

Since then I have found the method to be applicable to a large class of ores and furnace products; and that for estimating sulphur in slags and minerals by such fusions, and the subsequent use of bromine water, the method is also capable of wide application.

The chief objection to this method arises from the fact that in the fusion the silver crucible is more or less attacked by the caustic alkali, and that inasmuch as argentic chloride is quite soluble in a hot solution of potassium chloride, the silver will give trouble in the subsequent analytical determinations. To obviate this difficulty, W. Bettel advocates* the use of gold lined or plated platinum crucibles for such fusions with potassium hydrate.

This is a most valuable suggestion, and the method as originally detailed,† together with this modification, becomes applicable to the decomposition of nearly all silicates, and to the estimation of sulphur in nearly all inorganic as well as organic bodies.

I now find it is not necessary to make a fusion of any slag I have ever seen produced in connection with the lead-silver industry.

About two years ago, I learned from Mr. Hermann Schlapp, that he was using a "glassy" sample for analytical purposes, and that the slag he produced was decomposed with hydrochloric acid. I found to my surprise that if the hot flowing slag is allowed to run upon an iron rod, and while the slag is still hot, the rod is plunged into cold water, not only the physical, but the chemical, properties of the slag are so changed that upon drying the sample, it becomes completely decomposed by concentrated hydrochloric acid. The slag samples so taken are also readily attacked by most of the other inorganic acids, and are more or less decomposed by many of the organic acids.

Tartaric acid partially decomposes the slag, at a boiling temperature, giving rise to formation of much gelatinous silica.

Acetic acid very slightly attacks the slag on boiling and using strong acid (sp. gr. 1·055); and by filtration and the addition of ammonia some iron is precipitated, and the filtrate from the iron shows a small amount of lime.

A strong solution of sodium hydrate when boiled with the slag gives an intense green solution of sodium manganate (when manganese is present). Upon adding boiling water to this green solution, the manganese is precipitated.

Bromine water added to the finely-divided slag attacks it very vigorously, giving hydrated oxides of iron and manganese; if now a few drops of strong sulphuric acid be added, the iron and manganese are of course readily dissolved, leaving practically pure hydrated silicic acid. Inasmuch as the silicic acid so obtained does not filter well, no practical use of this very curious reaction can be made in the laboratory.

The above mentioned simple tests very plainly indicate, that by rapid cooling the slag is markedly changed in its chemical properties. If one closely examines a pot of newly drawn slag there will be observed on the outer edges a very fine shell or plate of glassy looking slag, varying in thickness from $\frac{1}{8}$ to $\frac{1}{32}$ of an inch—and also, where the slag has come in contact with the upper rim of the pot, there will be an appearance of a glassy or siliceous slag; this will be noted even when the slags are quite basic. All of these glassy surfaces or portions of the slag are generally completely soluble in hydrochloric acid, whilst if we allow the slag to cool *slowly*, alkaline fusions, or treatment with hydrofluoric acid, or heating with some strong acid in sealed glass tubes, is necessary to effect decomposition.

My method of taking the laboratory samples at these works is to use an ordinary tapping bar, and after there begins to form a very thin crust upon the newly drawn pot of slag, to throw aside this crust with one end of the bar, and immerse the other end into into the pot of slag about four inches; then very quickly withdraw and plunge into a bucket of water. This mode of taking the sample is applicable for both the assay and laboratory determinations; more care, however, is used in taking the laboratory sample, in order to secure a thin crust or shell, and also to lose no time in plunging into water.

In cases where much matte is formed, I think the method just detailed is the fairest by which the sample can be taken; that is, when due care is taken to save and rework the matte (or lead regulus). I have several times had the laboratory samples accidentally contaminated with plates of iron rust, scaling off from the iron pans in drying the sample; therefore I have procured porcelain or "granite" lined cups (shaped like the ordinary tin cups), and find they are admirably adapted for this purpose.

In order that my mode of procedure may be clearly understood, I will state very briefly the routine operations, viz. :—Allow the flowing slag to run upon the end of a steel bar, or dip the bar into the newly drawn pot of slag; plunge into water, dry the sample upon the slag pot, powder and pass through an 80-mesh sieve: now grind a small portion in an agate mortar for two or three minutes, and then weigh out the desired amount for analysis. It is generally unnecessary even to powder in an agate mortar, for the estimation of silica, iron, and lime; and only in making complete analysis of the slag, or where unusual care is required, is this operation performed.

After using the above method for over two years, I find that all slags containing an amount of silica varying from

* Chemical News, xliii., 94; see Note *Amer. Chem. Journ.*, 1881. vol. iv., No. 1., p. 57.

† *Scientific American Supplement*, No. 126, June 1, 1878.

30 to 42 per cent are entirely decomposed by hydrochloric acid.

I am led to the belief that the slags produced by the iron smelting industry will also be soluble in strong hydrochloric acid. I will be glad to hear from some of the iron smelters upon this point.

One of the main distinguishing features of a singulo-silicate slag in contradistinction from the bi-silicate (also the so-called "mixed" or sesqui-silicate), is that the singulo-silicate is soluble (generally) in strong hydrochloric acid, whilst the bi-silicate is only imperfectly soluble. I am inclined to the belief that almost *all* slags are soluble in concentrated hydrochloric acid, if we use the precaution to take a very thin crust or scale upon a steel bar, and immediately plunge into cold water. I do not find that by taking the samples in this manner, the chemical composition is materially changed,—certainly, it is not perceptible, so far as the silica, iron, lime, and manganese are concerned; and for practical working of the furnaces these are the main ingredients which the metallurgist desires to know. It would be reasonable to suppose that part of the sulphur, and perhaps a minute trace of arsenic, antimony, and phosphorus, would be eliminated in combination with hydrogen.

Before leaving this part of the subject, I will state that I see no reason why many slags could not be made a source for a number of inorganic salts; such as iron, lime, manganese, vanadium, &c.; perhaps a portion of the lead and silver could be saved; also the (gelatinous) silica. Nor is it unreasonable, in view of the above facts, to utilise even basic slags for the manufacture of building and paving brick.

Analysis of Slags.

After taking the slag sample, as previously indicated, weigh out from ½ to 1 grm., transfer to a covered casserole, add from the wash bottle a few drops of water, stir well, add concentrated hydrochloric acid, again stir, and digest over a free flame for a few minutes. The addition of water and the stirring prevents the slag from clotting or caking upon the bottom of the vessel.

Now add a few drops of nitric acid, both to ensure the oxidation of the iron and also to decompose a few specks of lead sulphide which are apt to form during the first addition of hydrochloric acid, and rise upon the sides of the vessel. Evaporate to dryness upon the water-bath; this is not a long operation if the analyst will use a minimum quantity of hydrochloric acid (say 6 to 8 c.c.). After the evaporation is completed, add a few drops of water, just sufficient to moisten the mass, and evaporate the second time. Now add a slight excess of concentrated hydrochloric acid, warm, dilute, and filter, washing the silicic acid with boiling water, and drop a small amount of hydrochloric acid around the edges of the paper; wash again with water. The moist residue, with filter-paper, is transferred directly to either a porcelain or platinum crucible, placed in an ordinary scorification cup, and dried before the assay muffle until the paper begins to carbonise. It is then placed in the muffle for about five minutes, removed, and allowed to cool, and the silica then weighed. The silica will be found perfectly white, not even tinted with iron, and the determination is as accurate as if a fusion had been performed.

For the determination of the iron it is advisable to take a second portion of ½ grm., boil with hydrochloric acid to complete decomposition in a casserole; then dilute with water and add a small piece of unamalgamated zinc, directly into the covered vessel. After a few minutes the cover is removed, washed, and the contents of the casserole are cautiously transferred by decantation to a *large* beaker, and diluted up to 500 c.c.; now add rather a large amount of concentrated sulphuric acid (say 25 c.c.), and titrate the iron with a standard solution of potassium permanganate.

It will be noted that it is entirely unnecessary to remove the silica in order to determine the iron, and furthermore, *time* is saved by reducing the iron by unamalgamated zinc directly in the vessel in which the decomposition of the slag is effected.

While the above mode of procedure may seem somewhat crude, yet it can be shown that all the precautions are taken to secure accuracy in estimating iron in a hydrochloric acid solution. Zimmermann proved that the addition of manganese sulphate allowed an accurate estimation of iron by potassium permanganate in a hydrochloric acid solution; and quite recently J. Krutzwig and A. Cocheteux showed* that manganese sulphate might be omitted by taking the precaution to use:—1, as little hydrochloric acid as possible for the solution of iron; 2, to reduce with zinc in a hydrochloric acid solution; 3, to use twice as much sulphuric as hydrochloric acid; 4, to dilute largely and use a dilute solution of permanganate of potassium.

For commercial work, a solution of permanganate about $\frac{1}{5}$ normal (6·5 grms. per litre), is recommended.

For the estimation of lime, two methods are used according to the accuracy to be attained. If for quick work, we wish to ascertain the percentage of lime, we use the filtrate from the silica as follows: heat this filtrate, add ammonia to slight alkaline reaction; then add a saturated solution of oxalic acid to dissolve the iron; boil for a few minutes, allow to stand twenty-five minutes, filter hot, wash well, and transfer to a casserole; add some hot water, and sufficient hydrochloric acid to dissolve the calcium oxalate, filter, and dilute with cold water. Now add rather a large amount of sulphuric acid; heat to boiling, and titrate with a solution of permanganate.

If a greater degree of accuracy is desired, the iron and alumina are removed as basic acetates, then manganese is separated by bromine water, the zinc removed by sulphuretted hydrogen, and the filtrate treated according to the usual method. Some manganese will invariably pass into the filtrate, when the iron is precipitated by ammonia, and will come down with the lime, introducing thereby an error to the extent of its presence. Where, however, the amount of manganese is small in comparison to the amount of iron, we can often use the first mentioned method with a great saving of time. For the manganese determination, take 1 to 2 grms. of the finely-powered slag, according to the amount of manganese present, and treat in a casserole with concentrated hydrochloric acid, with the addition of a small amount of nitric acid in order to convert all the iron into the ferric form. Now boil, and add sulphuric acid, gradually replacing all of the nitric and hydrochloric acids; the success of the operation depends upon the entire removal of the hydrochloric acid. Dilute to about 150 c.c. and boil; add an emulsion of zinc oxide in large excess, by which the iron is precipitated as ferric hydrate; filter off the silica, oxides of zinc and iron, and dilute up to 500 c.c. Some writers recommend, before the addition of zinc oxide, to neutralise with sodium carbonate and then clear up the solution with a few drops of nitric acid; this in practice we have found to be unnecessary.

Draw off from the diluted liquid, after thorough mixing, an aliquot part, say 100 c.c., transfer to a casserole, heat to boiling, and titrate with frequent stirring, with a normal solution of potassium permanganate, until the first rose tint is obtained. Calculate the per cent of iron corresponding to the permanganate used, and multiply this per cent found by 0·2946 = per cent, Mn.†

The manganese scheme as above stated is highly recommended, both for rapidity and accuracy; in fact there is no known method which we think will compare with it for technical and scientific work.

Occasionally arsenic determinations are required upon the slags; for this determination the writer thinks there is no known method which will compare with that of Prof. Pearce, as detailed by Mr. O. J. Frost in the columns of

* *Berichte der Deutschen Chemischen Gesellschaft*, 16, 1534. See note in *Amer. Chem. Jour.*, vol. v., No. 6, p. 459.

† See original article, *Zeit. f. Anal. Chem.*, 20th year, p. 271; also recent articles by Williams, Stone, and others in the *Trans. Amer. Inst. Min. Eng.*

the *Engineering and Mining Journal* (see vol. xxxv., p. 256). The method is a general one, and is applicable to ores, furnace products, &c.

The sulphur is determined by the "Fahlberg-Iles" method as follows:—

Fuse from 1 to 2 grms. finely-powered slag in a silver or platinum gold-lined crucible, with 25 grms. potassium hydrate for twenty minutes, cool, dissolve in water, filter off hydrated oxide of iron, &c.; now add 30 c.c. bromine water, and then concentrated hydrochloric acid to acid reaction; boil off excess of bromine, filter if necessary, add barium chloride, and proceed as usual for the treatment of barium sulphate.

Mr. Walter T. Page, chemist to these works, has kindly favoured me with the scheme for zinc determinations, which he is using with good success. I will take this opportunity to acknowledge my indebtedness to Mr. Page for much valuable aid throughout the entire preparation of this paper.

Zinc Scheme.

Treat 1 grm. of substance with 10 c.c. HCl + 5 grms. HNO_3 + 4 grms. H_2SO_4; acids concentrated and added in the above given order. Digest over a free flame to perfect decomposition, until thick fumes of H_2SO_4 appear; cool, dilute to 150 c.c., and filter; wash with hot water—now add 2 c.c. HCl and pass a rapid stream of H_2S to saturation; filter, and wash; boil filtrate, and oxidise with $KClO_3$. Precipitate iron and alumina with ammonia, using large excess; filter and wash. (If the percentage of zinc is large, it is best to re-dissolve and re-precipitate, and combine filtrates).

Add now HCl to decided acid reaction. Transfer to ½ litre flask—fill to mark, mix thoroughly, and draw off an aliquot part. Titrate this directly with a standard solution of potassium ferrocyanide,* using uranium acetate as the indicator. The ferrocyanide solution is made up with about 43 grms. K_4FeCy_6 per litre. Ammonium chloride interferes slightly with the accurate determination of zinc by this method; therefore we use the same amount of reagents, and correct for the ammonium chloride in each case. Manganese, nickel, and cobalt interfere—hence they are to be removed before titration.

The results of the fire assays for lead and silver are generally all that is necessary; if, however, a complete analysis of slags is to be made, the lead is estimated as a sulphate in the usual manner.

Some writers on metallurgy, and certain metallurgists, I am inclined to think, seem to over-estimate the importance of using wet methods for lead and silver. Dr. Percy is inclined to the belief† "that the dry method of assaying must always be resorted to as the only direct, accurate, and practical method" for commercial determinations of both lead and silver. The writer, after having used a number of proposed methods to facilitate the above determinations, has come to the same conclusion. There are, however, two wet methods, that deserve special mention; one of these is the method used at Bleiberg,‡ where lead sulphate is digested for one hour with sodium carbonate, the resulting lead carbonate dissolved in acetic or nitric acid, and the lead precipitated from this solution as a sulphate, in which form it is weighed.

The other method is the one proposed by A. E. Haswell,‖ and was subsequently altered by H. v. Jupner.§ This method, very briefly stated, is:—

Use a nitric acid solution of the substance to be determined, add an emulsion of zinc oxide, titrate in the cold to slight rose tint with a decinormal solution of permanganate, warm, and add a few drops of permanganate until the second tint is observed.

My experience with the foregoing method is, that the other substances mentioned by von Jupner, which may replace the zinc oxide, as potassium and ammonium hydrates, sodium and ammonium carbonates and also quicklime, do not give entire satisfaction, while by the use of zinc oxide, the results are exceedingly good. I, therefore, have come to the conclusion, that if one can only succeed in getting *all* the lead into solution as a nitrate, the method is an accurate one. Inasmuch as many lead ores contain lead sulphate and lead in other forms which are liable to tenaciously resist the ordinary solvents, the method should only be used with great discretion. In cases where lead sulphate is present, perhaps it could be advantageously removed from the siliceous residue by digestion with sodium carbonate, or the lead sulphate could be easily decomposed by metallic zinc in a hydrochloric acid solution.* The difficulty of obtaining zinc which is free from lead would militate against this mode of procedure. The volumetric estimation of lead by potassium dichromate is not used at any of the western metallurgical works, and, I think, for good reasons, as the method is valueless.

Volhard's method for the volumetric estimation of silver by ammonium sulphocyanide is a most excellent one, where it can be applied.

These are all of the ingredients the chemist will ordinarily be called upon to determine in connection with the lead-silver smelting industry. Slags, however, may and generally do contain any one or several of the following elements: Ba, Cu, Ni, Co, V, Sb, P, K, and Na. If any of these are to be determined, the methods as given by Fresenius, Rose, Sutton, Cairns, or Hart are followed.

In conclusion I will state that the above methods we also use daily for ores and furnace products, and we regard them for the performance of our work as invaluable.—*The School of Mines Quarterly.*

* See original paper by Dr. Fahlberg, *Zeit. Anal. Chem.*, 1874, 379.
‖ Percy's "Metallurgy of Lead," page 120.
‡ Percy's "Metallurgy of Lead," page 270.
‖ *Dingler's Polytech. Jour.*, Bd. 241, p. 393.
§ *Oesterreichische Zeit. für Berg. und Hütt.*, for 1881, No. 51.

REPORT ON GLUCOSE.†

This Report contains a great deal of useful information in regard to the manufacture of starch-sugar and the nature of the products obtained. There are twenty-nine factories in the United States, using, as nearly as can be estimated, 43,000 bushels of corn per day. The products are of various grades, which appear in commerce under the following names:—(*a*) The liquid varieties: glucose, mixing-glucose, mixing-syrup, corn-syrup, jelly-glucose, confectioners' crystal glucose. (*b*) The solid varieties: solid grape-sugar, clipped grape-sugar, granulated grape-sugar, powdered grape-sugar, confectioners' grape-sugar, brewers' grape-sugar.

The most general purposes for which starch-sugar is used are:—(1) For the manufacture of table-syrup; (2) A substitute for barley-malt in the brewing of ale or beer; (3) As a substitute for cane-sugar in confectionery; (4) For the adulteration of cane-sugar, to which it is added to the extent of 20, or more, per cent; (5) For the manufacture of artificial honey; 6. For the manufacture of vinegar.

The transformation of the starch into dextrose is effected in most of the factories by means of sulphuric acid, though in some oxalic is used, and the use of phosphoric acid has been suggested. The normal products of the transformation by means of these acids are, as is well known, dextrose, maltose, and dextrin. The commercial products consist of these substances in different proportions, the liquid products containing more dextrin and maltose than the solid products. In the latter the analyses showed the presence of from 72 to 73·4 per cent of dextrose, and from 4·2 to 9·1 per cent of dextrin. In the "glucoses" or liquid products analysed the amount of

* See article in *School of Mines Quarterly* for March, 1882, by the writer.

† Prepared by the National Academy of Sciences, in response to a request made by the Commissoner of Internal Revenue. Washington: Government Printing Office. 1884.

dextrose was found to vary from 34·3 to 42·8 per cent, and the amount of dextrin from 29·8 to 45 3 per cent. The mineral constituents were found to be present only in insignificant quantities, and to be of harmless nature.

In the fourth sub-division of the report the subject of the relation of starch-sugar to health is discussed. The question, "Is the use of 'glucose,' or 'grape-sugar,' injurious to health?" is asked, aad the report then proceeds:

"This is certainly one of the most important questions that can be asked regarding the substance under consideration. It has been discussed very freely, but on a very insufficient basis of facts. Indeed, so far as the products made from corn-starch are concerned, it appears that no experiments have ever been made with reference to their effects upon the system. It is essential in a discussion of this subject to keep clearly in mind the fact, that while it is undoubtedly true that the pure chemical substances, dextrose, maltose, and dextrin, are not injurious, there may be other substances present in small quantities in the commercial products, and that these are capable of producing injurious effects; or it may be true that when the commercial products are changed by fermentation substances of injurious character are formed or left unfermented.

"In Germany, where large quantities of dextrose are made from potato-starch, experiments bearing upon the question of the presence of injurious constituents have been made with the commercial products. Some of the results obtained indicate that after fermentation of potato-sugar there are left substances which are injurious, while others indicate that this is not true. Among those who have experimented on the subject A. Schmitz, Nessler, and Freiherr von Mering should be specially mentioned. Schmitz* fermented potato-sugar, and, evaporating the products down to small volumes, administered known quantities of the residues to cats and dogs, and in a few cases to human beings. The results obtained were uniform, and showed that the substance caused sickness, as headache, sweating, and loss of appetite.

"Later, Nessler† undertook similar experiments, and obtained similar results. He experimented upon his assistant and himself. One of his experiments is here described. He allowed a 20 per cent solution of potato-sugar to ferment after the addition of a small quantity of hops. After the fermentation was over the liquid was filtered, a litre evaporated down to a syrup, and then diluted up to 100 c.c. This solution had a disagreeable bitter taste. Nessler took 50 c.c. of it at 7 a.m., and the same quantity at 10 a.m., each portion corresponding to 100 grms. of potato-sugar. Toward noon he began to feel uncomfortable, but not so much so that he could positively attribute his condition to the beer extract. At 2 p.m. the residue from 100 grms. potato-sugar was again taken, and now in about an hour there followed profuse perspiration and violent headache, both of which continued until night. A few days later his assistant took the residue from 90 grms. of sugar, the fermented liquor having been evaporated down to two-fifths its original volume. He soon experienced difficulty in breathing, and broke out in a cold sweat; at dinner he had no appetite, and was obliged to throw up the little soup he did take. In the afternoon he had a violent headache, which continued until evening.

"Nessler concludes his paper with these words:—'It is hence beyond a doubt true that in the liquid obtained in the fermentation of potato-sugar there are substances injurious to health. If the question is asked whether this is true of all commercial potato-sugars, as well as of the sugar examined, we cannot give a definite answer.

"'In the case of all varieties of potato-sugar thus far examined there remains after evaporation of the fermented liquid a bitter-tasting extract, which turns the plane of polarisation to the right, and it is very probable that all of them may act injuriously upon the health, in varying degrees, according to the greater or less purity.

"'As in buying the sugars it is not possible to determine whether the harmful substances are present or not, potato sugar should not be used for the preparation of beverages,* until it can be prepared in perfectly pure form.'

"Directly opposed to the results of Schmitz and Nessler are those obtained by Freiherr von Mering.†

"This writer experimented upon dogs, cats, rabbits, and human beings, in much the same way as Schmitz and Nessler had done, and he concludes that the unfermentable residues from potato-sugar are not at all objectionable.

"Later, Schmitz‡ replied to Von Mering, upholding his first results.

"It hence appears doubtful whether there are injurious substances in potato-sugar, and it is highly desirable that the experiments on this subject should be repeated by those who have not thus far taken active part in the discussion. Even though it should eventually be shown that potato-sugar is or is not objectionable, it would not necessarily follow that the same is also true of maize-sugar.

"As, so far as we know, no experiments had been made upon starch-sugar, we carefully repeated the experiments described above, using several of the samples of glucose and grape-sugar, the analyses of which are given in the preceding part of this report.

"We were fortunate in securing for this work the assistance of Dr. J. R. Duggan, of the Johns Hopkins University, who has for some time past been occupied in experiments upon fermentation, and who is hence fully familiar with all the precautions necessary to secure reliable results. The fermentations were carried on in a new cellar, which fortunately chanced to be available, so that the danger of abnormal fermentation was reduced to a minimum.

"Pure glucose cannot be fermented by the simple addition of yeast in small quantity; for yeast, like all living matter, requires certain nitrogenous and inorganic materials for its own nourishment. As has been shown by Pasteur, this want may be supplied by the addition of certain salts,, such as ammonium tartrate, calcium phosphate, &c.; but as these cannot be added in exactly the necessary proportions, some would be likely to remain in the solution after fermentation was complete, and, if taken into the stomach along with the glucose residue, would probably produce an effect of its own which might be attributed to the glucose.

"It is not easy to obtain in sufficient quantity a liquid furnishing a proper medium for the growth of yeast which does not also contain glucose; and, for this reason, it was first necessary to determine the effect, if any, of the unfermentable residue from this glucose.

"Experiments Nos. 1, 2, and 3 were made for this purpose. The nutrient liquid used was barley-wort, on account of the fact that it is most commonly used in brewing for commercial purposes.

"This liquid contains much more nitrogenous matter than is necessary to support the yeast during its fermentation, and therefore it still forms a good medium for the growth and development of yeast after it is considerably diluted with a solution of glucose.

"The method of experimenting was as follows: The barley-wort, of the concentration usually employed for making beer, was mixed with the glucose solution, and the whole heated to boiling by passing steam through a coil of block-tin tubing placed in the tub. The tube was then connected with the hydrant, and water passed through it until the solution was well-cooled. It was then allowed to flow slowly over a wide board, for the purpose of thoroughly aerating it. The temperature was reduced to about 10° C., and about a pint of yeast added. Fermen-

* Beiträge zur diätetischen Beurtheilung des gallisirten Weines· Bonn, 1878.

† Wochenblatt des landwirthschaftlichen Vereins im Grossherzogthum Baden, 1880.

* One of the uses to which potato-sugar is put in Germany is as an addition to poor wine.

† *Deutsche Vierteljahrschrift f. öffentliche Gesundheitspflege*, 14, 325.

‡ *Ibid.*, 481.

tation was carried on in a cool vault, and was allowed to continue until very little sugar was left in the solution and the yeast had all settled to the bottom of the tubs. A sufficient quantity of beer was then syphoned off and evaporated slowly over the water-bath to about one-tenth its volume. The residue consisted principally of dextrin, nitrogenous matter from the wort, glycerin, succinic acid, and probably other products of fermentation in very small quantities. It formed a thick, dark-coloured syrup, of very disagreeable taste, especially when wort containing hops had been used. For this reason, sweet-wort was used in most of the experiments. All of the fermentations were carried on by the low process—that is, with bottom yeast at a temperature of from 8° to 10° C.

"Two experiments were tried with the high process, but it was found to be impracticable on the small scale, on account of the development of bacteria, due to the higher temperature. As the difference in the two processes is essentially one of temperature only, there is no reason to suppose that they could in any way give different results.

"The amonnt of yeast added to each tub was about one-half litre. This was carefully examined with the microscope, both before and after fermentation, to guard against the presence of foreign ferments that might produce injurious products. The glucoses used were of the various manufactures already mentioned, and embraced the different grades of solid and liquid products.

"The extracts were taken at different hours of the day, both before and after meals. The quantity usually taken contained the residue from 125 grms, of glucose; but in experiment No. 8 this quantity was increased so as to correspond to 200 grms. It seems useless to try still larger quantities, for it is probable that if much more was taken the normal products of fermentation, such as succinic acid, would produce some effect.

"*Experiments* 1 *and* 2.—Thirty litres of sweet-wort and the same quantity of hopped wort were separately fermented, the process lasting, in each case, one week. Five litres of the resulting liquid were evaporated to 750 c.c., and 300 c.c. of the extract taken internally. The same experiment was tried by two individuals, but no effect was produced. The amount of extract taken corresponded to two litres of the beer.

"*Experiment* 3.—In this experiment there were used 15 litres of sweet-wort, to which were added 15 litres of a 12·5 per cent solution of cane-sugar. Five litres of the liquid were evaporated to 500 c.c., and 200 c.c. of the extract taken, with no effect. The amount of extract taken represented 125 grms. of cane-sugar.

"*Experiment* 4.—Fermented 15 litres sweet-wort and 15 litres of a 12·5 per cent solution of grape-sugar. (Sample No. 12.) Five litres of the liquid were evaporated to 500 c.c., and 200 c.c. taken. No effect was produced. On the following day, the same amount of residue was taken, and with no effect. The amount of extract taken corresponded to 125 grms. of glucose in each experiment.

"*Experiment* 5.—Fifteen litres of sweet-wort and 15 litres of a 12·5 per cent solution of grape-sugar (Sample No. 7) were fermented. The same amount of extract was taken as in the last experiment, with the same results.

"*Experiment* 6.—The details of this experiment were exactly the same as those of the last. The substance was a commercial glucose. (Sample No. 14.)

"*Experiment* 7.—Fifteen litres of hopped wort, with 7·5 litres of a 25 per cent solution of commercial glucose (Sample No.1), were fermented. Four litres of the fermented liquid were evaporated down to 400 c.c., and of the residue 150 c.c. were taken. No effect was felt.

"*Experiment* 8.—Fifteen litres of hopped wort and 7·5 litres of a 25 per cent solution of grape-sugar (Sample No. 13) were fermented. Five litres of the fermented liquid were evaporated to 500 c.c. and 200 c.c. taken. No effect was felt. The extract represented 160 grms. of grape-sugar.

"The experiments described above occupied about two months, during which time Dr. Duggan repeatedly took large quantities of the extracts. At the end of the experiments, and during the entire period, his health continued excellent.

"There was nothing whatever to indicate that the extracts contained anything injurious to health, and the conclusion seems to be fully justified that the samples examined by us, and which we have every reason to believe were fair average samples of the substances found in the market, contained nothing objectionable from a sanitary standpoint. In the experiments the experimenter took into his system everything that could possibly be objectionable contained in from 120 grms. to 160 grms. of the glucose, or grape sugar, *i.e.*, from a quarter to a third of a pound. It must be borne in mind, further, that the extract which was taken into the stomach must have contained any objectionable mineral as well as organic substances present in the glucose employed. Hence, the results seem to be final as regards the injurious nature of glucose or grape-sugar made from maize.

"These experiments extended over a period of only about two months. On the question, therefore, whether any injurious effect would follow the continuous use of this material, the committee has no information.

"Our experiments have, of course, no direct connection with those of Schmitz, Nessler, and Von Mering, already referred to. These gentlemen experimented upon potato-sugar as furnished by manufacturers in Germany. Our conclusions are valid only for maize-sugar as furnished by manufacturers in this country.

"It should be further remarked that, although our experiments show conclusively that the products of fermentation of glucose are not dangerous to health, it does not necessarily follow that beer made by the fermentation of glucose is as good as that made in the usual way. That is a matter which does not fall within the scope of our investigation."

The report was prepared by a committee of the National Academy of Sciences, which consisted of Professors George F. Barker, of the University of Pennsylvania, W. H. Brewer, of Yale Cottage; Wolcott Gibbs, of Harvard College; Charles F. Chandler, of Columbia College; and Ira Remsen, of Johns Hopkins University.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING SEPTEMBER 30TH, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, October 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from September 1st to September 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of the 182 samples submitted to examination, two were found to be "*very slightly turbid*," and one "*slightly turbid*." The remaining 179 samples were perfectly clear, bright, and well-filtered.

The results as to the state of aëration of the whole of the samples, and as to the degree of freedom from colour of all but the one sample recorded as "slightly turbid," have not differed appreciably from the results met with in the previous summer months' supplies. The proportion of organic matter has continued low, though not so exceptionally low as was noticeable in the supply for August.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

NOTICES OF BOOKS.

A Treatise on the Purification of Coal-Gas and the Advantages of Cooper's Coal-Liming Process. By R. P. Spice, M. Inst. C.E. London: E. and F. N. Spon.

In the very first sentence of this book the author strikes a significant key-note. Says he: "Several years have elapsed since modern chemical knowledge was brought to bear, inconveniently to say the least of it, upon the Gas Manufacturers of London; and many hard battles have been fought in Parliamentary Committee Rooms concerning the vexed question of what are called sulphur compounds. Formerly these obnoxious and troublesome bodies were not thought of, and probably not known except to the learned who inhabit the higher regions of scientific life; who can tell common people more than they would like or care to know concerning the air we breathe, and the water or milk which we drink or ought not to drink."

Frankly speaking, we do not at all like the spirit of these remarks. No doubt it would be exceedingly convenient for the manufacturers of various products if "common people" would only buy them without enquiries as to their purity. But even the said common people have been able to observe the injury done to books, pictures, dyed and printed tissues, metal articles, &c., in rooms where an impure gas is used for lighting. Hence we are hard-hearted enough to prefer the convenience of the many to that of the few. We think ourselves not only entitled, but in duty bound, to warn the "common people" against hydrogen sulphide and carbon disulphide in the gas they consume. As a matter of course, if any methods can be found of obtaining gas in a state of greater purity an advantage will accrue to both sides. Mr. Spice's object in the work before us is to demonstrate the advantages of the "Cooper process," *i.e.*, the admixture of the coal before distillation with a certain quantity of lime. But these advantages might have been equally well shown without the initial sneers at "modern chemical knowledge" and the "learned who inhabit the higher regions of scientific life."

The advantages which the Cooper process is said to possess are, as claimed in the patent, "an increased yield of ammonia and ammoniacal products," "a diminution of the impurities in crude gas"—that is, evidently in the gas before it has been subjected to purification—and, lastly, that "the resulting coke is for certain purposes improved."

The first of these claims is, on theoretical principles, indisputable. Every chemist knows that a nitrogenous organic body ignited with lime must give off more of its nitrogen in the form of ammonia than if ignited alone. It is here laid down that the increase in the yield of ammonia by the Cooper process is very considerable. According to Mr. Wanklyn the yield is at least doubled. As to the tar produced,—a very interesting subject to chemical manufacturers—we find no precise statements either concerning quantity or quality.

The point on which the greatest accent is here laid is evidently the suppression of sulphur compounds. It is admitted that the addition of lime to coal for this purpose has been claimed before, in patents which have now expired. But the validity of Mr. Cooper's patent is maintained, it appears, on no less an authority than Mr. R. E. Webster, Q.C., on the grounds, apparently, that a different proportion of lime is used than had been proposed by former inventors. Haddock (1819) used 12½ per cent of lime, and did not mix it with the coal; Leslie (1859) took 10 per cent of slaked lime, and mixed it with the coal. Mr. Cooper, as here quoted, takes about ½ cwt. of quicklime per ton of coal and slakes it with its own weight of water, thus bringing the total of slaked lime to 5 per cent. Into the questions of patent-right which here suggest themselves we cannot enter.

We should, however, like to know Mr. Spice's warrant for asserting that the Leslie process is "absolutely impracticable and valueless," especially if it, as he says, never has been worked?

We are told that the Cooper process supersedes the lime purifiers—wet or dry—thereby doing away with that very objectionable article "blue billy," and that though it does not render the oxide of iron purifiers unnecessary it increases their vitality from a week to a year.

As regards the gas made, Mr. Spice makes no "claim" for any gain in either quantity or illuminating power.

The effects of the liming process upon the coke are evidently a bone of contention. Some persons who have given it a trial report an increase and others a decrease in quantity. Some practical authorities assert that there is a deterioration in quality, whilst others contend that the combustibility of the product is increased. These are points upon which practical metallurgists will easily reach a final decision.

We think that Mr. Spice would have served his cause quite as well had he adopted a more courteous tone towards dissidents.

The Electricians' Pocket-Book: The English Edition of Hospitalier's "Formulaire Pratique de' l'Electricien." Translated with additions by Gordon Wigan, M.A. Cassell and Co., Limited: London, Paris, and New York.

We have here a work which must prove exceedingly useful to all persons—and they are rapidly increasing in numbers—who are engaged either in the theoretical study of electricity or in its practical applications. The author begins with definitions, first principles, and general laws. He goes on to units of measurement, measuring instruments, and the methods of using them for measuring currents, resistances, potential and electromotive force, electrical quantity, capacity and energy, and for testing cables. In the next part we find a variety of practical information and experimental results.

We regret here to find that both author and translator have retained the very objectionable hydrometer scale of Beaumé instead of direct specific gravity, or Twaddell's scale, which two admit of mutual conversion by the simplest calculation. If England is called upon to abandon her traditional standards of weight and measure France may, in turn, be not unreasonably expected to give up Beaumé.

The subject of conductors brings us to the "Birmingham wire guages," of which, for the promotion of confusion, there exist no fewer than fourteen!

In the chapter on the production and application of electricity there is a short description of all the principal

batteries in use; of accumulators; of thermo-electric batteries, and of the mechanical generators of electricity.

Some of the more important applications of electricity are next passed in review, such as the transmission of power, with special notice of the experiments of Marcel Deprez; electric lighting, telegraphy, and telephony.

Lastly, we have a chapter of recipes and processes. Here we notice that Mr. Wigan has in one case translated the French term *eau forte* (nitric acid) too literally. The corresponding English term, still used by artisans in various branches of trade is *aqua fortis*.

There is, in conclusion, a bibliography of the authorities consulted, and an index to the tables contained in the work.

Manual of Chemical Manipulations, followed by a Manual of Operatory Chemistry. (Manuel de Manipulations Chimiques suivi d'un Manuel de Chimie Operatoire.) By Fr. de Walque. Louvain: D. Aug. Peeters-Ruelens.

In that part of the work before us which is devoted to chemical manipulations the author takes into consideration, first, working with glass, the mechanical division of solids, the weighing of solids, and the weighing and measuring of liquids and gases. He then turns successively to operations in the dry and in the wet way.

Upon glass-working M. de Walque lays a great, but not an exaggerated, weight. At the same time it is evident that no man can by reading become an expert glass-worker, without seeing how the various operations are actually performed.

The instructions for pulverising and otherwise comminuting bodies convey not a few hints which will be very useful to the student.

The directions for weighing, for the management of the balance, and the verification of weights are also satisfactory. The author declares, not without truth, that in laboratories where numerous students work the exactitude of the balances cannot be depended on, and he recommends in such cases Borda's methods of double weighing or of substitution.

In speaking of burettes, the "English burette" (Binks's) is said to be exceedingly convenient for use, an opinion which we do not share, seeing that after a quantity of the liquid has been dropped out at the orifice some time has to elapse before the quantity remaining reaches its final level, not to speak of the effect due to the heat of the hand. Mohr's burette is also mentioned, but without the name of its author.

We next come to the directions for the production and application of heat. It may perhaps surprise us that spirit-lamps should be mentioned before coming to gas as used in the Bunsen burner. But on the Continent alcohol is decidedly cheaper than in England, and is not, like the ordinary methylated spirit sold here, rendered practically useless by the addition of shellac.

In places where gas was not procurable we have seen the outside of platinum capsules densely coated with soot, owing to this unfortunate ingredient. Mention is here also made of those spirit-lamps on the principle of the aelopyle. These instruments sometimes ignite a crucible beautifully, but just at the last moment they throw a somersault, overturning the crucible and spilling its contents. The gas-furnaces of Perrot, Schlösing, &c., are mentioned, but we find no notice of the "solid flame" burner of Fletcher, which is very useful in the laboratory. We cannot, however, follow the author in his very complete instructions for all the various processes occurring in chemical practice.

So far the work before us may be regarded as a treatise on chemical manipulations. The remaining part is a manual of experimental and analytical chemistry, beginning with the development of hydrogen gas. Here we find little deserving special notice, whether commendatory or otherwise. The properties and reactions of the various compounds and the methods for their preparation are, as far as we perceive, laid down in accordance with the present state of knowledge. It might have been well, however, in speaking of arsenic hydride, to have cautioned the student concerning the danger of inhaling this gas.

An appendix gives a set of tables for qualitative analysis.

The next section of the book is devoted to a brief view of organic chemistry, somewhat curiously arranged, and in which we find no mention of some of the most important bodies.

The illustrations given at the end are numerous, but by no means so well executed as we often find in French works.

CORRESPONDENCE.

THE LATE DR. ANGUS SMITH'S ALKALI REPORT.

To the Editor of the Chemical News.

Sir,—As the one who had charge of Dr. Angus Smith's proof-sheets I think it a duty to call attention to the unintelligibleness of the last two lines in his Presentation of the Alkali Report, as it may reflect on the writer's clearness in dictation, on the Secretary's carelessness, or on my neglect in allowing such to pass uncorrected.

This non-meaning is not found in Dr. Angus Smith's manuscript, nor in the first copy of Report sent for revise, nor in the revised copy sent to the Secretary of the Board.

Had this mistake occurred in Dr. Angus Smith's lifetime it would have been a matter of little or of no importance, as any reader would at once see that he could not have written such meaningless sentences.—I am, &c.,

Jessie Knox-Smith.

Gowrie House, York Place, Manchester,
October 7, 1884.

DR. EDMUND W. DAVY'S MOLYBDIC ACID TEST FOR ALCOHOL.

To the Editor of the Chemical News.

Sir,—Amongst the "Chemical Notices from Foreign Sources" in the Chemical News, vol. l., p. 175, there is a paragraph under the heading "A Reaction for Alcohol," from which it would appear that the reaction, which I had proposed several years ago as a test for alcohol, had recently been brought forward by some Continental chemist who was evidently unaware that it had been previously published.

The reaction referred to is that which takes place on bringing (under particular circumstances) a solution of molybdic acid in strong sulphuric acid in contact with alcohol, when a deep azure blue colouration is produced. This test, which is one of exceeding delicacy, I brought before the Royal Irish Academy in the year 1876, when it was first published in its *Proceedings;* and it subsequently appeared in the Chemical News, vol. xxxiv., p. 137, where I pointed out some of its useful applications. In the following year I also published in the London *Pharmaceutical Journal* (vol. viii., 3rd series) a further application of this test, viz., its employment in the detection of alcohol when used as an adulterant of the essential oils, for which purpose it is especially serviceable.

As to the exception which Messrs. Gladstone and Tribe have taken to this test (alluded to in the paragraph referred to), on the ground that this reaction is inconclusive, since a series of other reducing agents produce the same

effect as alcohol, this circumstance I myself pointed out when proposing the test; but I may observe that the same objection applies to all the other tests that have hitherto been proposed for that substance; and, notwithstanding this defect, I still maintain that from the facility of its application and its extreme sensitiveness it may be very usefully employed as a test for alcohol, not only in the cases I have pointed out in my published papers, but in many others.—I am, &c.,

EDMUND W. DAVY, M.D.

Fortfield Terrace,
Templeogue, Co. Dublin,
October 21, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwis expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 13, September 29, 1884.

The Vegetation of the Amaranthaceæ: Distribution of the Fundamental Principles.—MM. Berthelot and André.—The increase of lignine and of analogous principles extends to all parts of the plant, both absolutely and relatively. It forms ultimately three-fourths of the weight of the stem and the root in vigorous amaranths, but remains less in the leaves. In species where vegetation is feeble and fructification incomplete the proportion of lignine scarcely exceeds half the total weight. The proportion of soluble and transportable hydrocarbons increases during vegetation; its maximum coincides with the epoch of inflorescence, especially in the stem. The albumenoid principles are at first concentrated in the leaves but afterwards in the leaves and the flowers. The potassium salts, the presence and proportion of which are correlative with phenomena of oxidation, are at first concentrated in the stem and leaves. Subsequently they are more uniformly distributed. The roots contain the lowest relative proportion. Insoluble mineral matters tend to accumulate in the leaves except in plants which vegetate feebly, where they seem to remain in the roots.

Separation of Cerium and Thorium.—M. Lecoq de Boisbaudran.—The author proceeds as follows; the mixed solution, almost neutral (sulphates or chlorides) are treated with a few drops of hydrochloric acid and boiled for a few minutes along with turnings of pure copper. The per-salts of cerium are thus entirely reduced to the minimum stage. There is then added to the liquid, without removing the copper turnings, a decided excess of cuprous oxide, and the whole is kept at a gentle boil for at least three quarters of an hour. The precipitate, collected on a filter, is washed with distilled water previously boiled with a little cuprous oxide. This precipitate, which contains the thoria as well as a small quantity of cerium oxide (due especially to deficient washing), is re-dissolved in hydrochloric acid, mixed, if needful, with a little nitric acid. The copper is removed either by means of sulphuretted hydrogen in a very acid solution, or by an excess of ammonia. The ceriferous thorina is submitted a second, or at most a third, time to the same treatment, and is then free from cerium and no longer takes an orange-yellow colour on contact with oxygenated water. The various ceriferous solutions are collected and freed from copper by means of sulphuretted hydrogen or ammonia. Considering the facility of repeating the treatment with copper or cuprous oxide there is no inconvenience in leaving rather large traces of cerium in the first precipitate of thoria obtained, but it is essential this latter oxide should be completely precipitated. It is safer, therefore, to prolong the boiling of the liquid with cuprous oxide for an entire hour. If there is any suspicion that traces of thoria have been left in the mass of ceria it may be re-dissolved in hydrochloric acid, and the solution submitted to a new and more prolonged ebullition in presence of copper and cuprous oxide.

Solubility of Gallium Ferrocyanide: Correction of a Former Statement.—Lecoq de Boisbaudran.—The author, when treating of the separation of gallium from manganese, observed that at ebullition gallium prussiate is more easily soluble in its mother-liquor if there is added to it a certain quantity of manganese chloride. Other experiments, however, seem to show that the effect obtained depends not on the presence of the manganese, but on a decided acidity of the solution of manganese chloride employed. In fact, if we add a sufficient quantity of hydrochloric acid to the mother-liquor of pure gallium ferrocyanide, this also dissolves on boiling.

The Products obtained on Treating Tellurium with Nitric Acid.—D. Klein and J. Morel.—It is generally admitted that in the reaction of tellurium and nitric acid the only product is tellurous anhydride. M. Klein in a former communication described a basic telluric nitrate obtained on attacking tellurium with a large excess of hot dilute nitric acid. The authors having re-examined the matter find that on treating tellurium with nitric acid there is formed—(1) a solution of tellurous hydrate soluble in nitric acid (at about 0°); (2) a tellurous nitrate, which is decomposed at 70° to 80°, forming tellurous anhydride and a basic nitrate. This tellurous nitrate is formed at about 20°, and is decomposed spontaneously on standing, even in the cold, into basic nitrate and anhydride. The basic telluric nitrate is also decomposed by water. The properties of tellurous anhydride have been very incorrectly described. It is spoken of in the text-books as slightly soluble in water. But it is almost as insoluble as barium sulphate, 1 part requiring for solution 150,000 parts of water.

Journal de Pharmacie et de Chemie.
Series 5, Vol. ix., June, 1884.

Assay of the Quinine Sulphate of Commerce.—J. C. DeVry.—The author states that all the quinine sulphates of commerce which he has analysed contain cinchonidine sulphate in proportions ranging from 5 to 18 per cent. This is not an adulteration, but a natural consequence of the presence of conchonidine in the barks employed. The manufacturer, though he can prepare the acid quinine sulphate chemically pure, is unable to produce the ordinary (basic) quinine sulphate pure on an industrial scale. If he could effect this it would not be accepted in the market, as a *light* sulphate is demanded. But the basic quinine sulphate, when chemically pure, is not light, but relatively heavy. When 5 grms. of commercial quinine sulphate are dissolved in 200 grms. of boiling water, and adding 5 grms. of Seignette's salt, likewise dissolved in a very small quantity of boiling water, the liquid remains limpid for an instant, and then forms on cooling regular crystals. After twenty-four hours these crystals are carefully collected on a filter, washed with the smallest possible quantity of water, and dried in the air. On treating in this manner the various quinine sulphates of commerce it will be found that the weights of tartrate obtained are not always identical, because the quantity of these tartrates depends on the water of crystallisation and on the presence of cinchonidine, the tartrate of which does not crystallise out under these conditions, but remains in solution. Consequently the weight of the tartrates obtained is one mark of the commercial value of quinine sulphate. On treating various samples of quinine sulphate in this manner the author has obtained quantities of tartrates varying from 88·84 to 93·14 of the sulphate employed.

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THE CHEMICAL NEWS.

Vol. L. No. 1301.

ON THE CHEMISTRY OF POTABLE WATER.*

By Professor ODLING, M.B., F.R.S., F.R.C.P.,
President of the Institute of Chemistry.

I. *Sources of Water Supply.*

The water of most towns is derived, as is well known, from one or other of three typical sources, constituted respectively by springs, or streams, or lakes; this last-named source being taken to include not only natural lakes, but also those huge artificially formed reservoirs, in which the surface water collected from more or less extensive gathering grounds is retained by means of embankments, and stored up for distribution to consumers. Although some streams, indeed, are fed largely by springs, and some lakes are little else than local expansions of streams or rivers, still a general distinction in character between supplies derived from the three just spoken of typical sources, is, on the whole, broadly recognisable; and this, notwithstanding the fact of the considerable differences in composition manifested by individual spring waters, derived from different springs or wells, by individual stream waters, derived from different streams or rivers, and by individual lake waters, derived from different lakes or reservoirs. Despite the marked preference of a few authorities for some one variety of source to the exclusion of the others, the majority of engineers have come to recognise each variety as having its own characteristic excellences and concomitant defects, and are accordingly ready to avail themselves, in different cases, of whatever kind of source is rendered by local circumstances most available and suitable for the particular town to be supplied. From all three varieties of source alike, numerous large populations have been furnished for generations past, with an abundant, and, as the result has shown, with a satisfactory and wholesome supply of water; although, indeed, in a few special instances, supplies from all three varieties of sources alike have, in different ways and under exceptional circumstances, proved detrimental to the health, and even, in certain cases, fatal to the lives of some among the population supplied. All three varieties of source have, under the best advice of the time, been continually resorted to from the earliest period of water supply undertakings, nearly three centuries ago, down to the present day. Thus, while the youngest of the companies supplying London has obtained its supply, since 1862, wholly from deep wells sunk in the chalk, the new works for the supply of Liverpool and Manchester respectively, which may both take rank among the greatest hydraulic undertakings of the century, are intended to introduce and distribute river water in the one town and lake water in the other. All experience, indeed, goes to show that the supply of excellent water is not confined to its supply from any single variety of source; and that for the purpose of water supply, there are alike good wells and bad wells, good lakes and bad lakes, good rivers and bad rivers. Just, moreover, as the best of river waters or lake waters will fall short in regard to an excellency characteristic of well water, so will the best of well waters fall short in regard to an excellency characteristic of lake water or river water. The comparison of one sort with the other sorts of water must be made as a whole. To select arbitrarily the special good point of one sort of water as a standard, to the neglect of the countervailing good points of other sorts, and to measure the quality of the other sorts solely in reference to this selected standard, is clearly the conduct rather of an advocate than of a judge.

II. *Purity of Water.*

Water, as conceived of by the chemist, is a definite compound of 100 parts by weight of oxygen, united with 12·5 parts by weight of hydrogen. So exceedingly difficult is it of production, even if it ever has been produced in an absolutely pure state, that it may be regarded rather as an ideal than a real chemical substance. All natural water, besides the matter, never entirely absent, which it holds in suspension, is a solution of various mineral matters, of various organic matters, and of various gases in the ideal water, or protoxide of hydrogen, of the chemist. Of the different kinds of foreign substance habitually or exceptionally present in natural water, some kinds are beyond question prejudicial, and in particular cases highly prejudicial; most kinds are simply innocuous; while not a few kinds, as saline matter in moderate proportion, and more particularly dissolved aërial matter, are positively beneficial. Looked at, however, from a strictly chemical point of view, any matter whatever foreign to the ideal chemical compound water, constitutes an impurity of the natural water in which it occurs, whether this foreign matter be a prejudicial or a beneficial constituent, whether it consists of sewage matter, by which the water is fouled, or of healthful oxygen, by which it is aërated. The chemist uses the word pure, not in the sense of opposite to nasty, but much in the way it is often used in ordinary language, to express the exclusion from one thing of anything else, whether better or worse. Thus, we talk no less familiarly of pure rubbish or pure dross than of pure gold. We speak of pure nonsense as readily as we speak of pure truth, irrespective of the circumstance that the nonsense would be benefited, though to the prejudice of its purity, by its contamination with a few grains of sense. So chemists speak of pure water, irrespective of the circumstance that, for all the needs of life, the water is benefited, though to the prejudice of its chemical purity, by the presence both of its dissolved gases and of a proportion of dissolved saline matter. Chemists, then, are in the habit of using the word "purity" to signify oneness of chemical nature. Accordingly, in the eyes of a chemist, the matter, for example, of an old copper penny would have its degree of purity equally lowered by the same addition made to it of any kind of other matter, whether of base metal, like tin, or of noble metal, like silver, or even gold. Similarly, in the case of natural water, the small proportions of other substance existing together with the main substance, protoxide of hydrogen, interfere with the oneness of its chemical nature; or, in other words, constitute the natural water a mixture of substances, instead of being a single substance, which is alone looked upon by the chemist as a pure substance. It follows, that the water of the chemist is one thing, the water of nature another. The ideal water of the chemist is a single substance; the water of nature, like the air of nature, is a mixture of substances. Just as this last is a variable mixture of the pure chemical substances—nitrogen, oxygen, water vapour, carbonic acid, and ammonia, with traces of various other kinds of matter, so is the water of nature a variable mixture of the pure chemical substances—protoxide of hydrogen, common salt, saltpetre, gypsum, limestone, carbonic acid, nitrogen, and oxygen, &c., together with various kinds of organic matter. Air, from which the minor constituents of atmospheric air have been carefully abstracted, is sometimes spoken of as purified air; but air, deprived in this way of its so-called impurities, is absolutely incapable, in relation alike to animal and vegetable life, of fulfilling the functions of an atmosphere. The substitution of such purified air for actual atmospheric air would mean the cessation on the earth's surface of all life as it now exists. Similarly, with regard to natural water, some of its minor constituents we know to be essential, others of them we have reason to think advantageous to the fulfilment of its functions in nature. Bearing in mind, indeed, the interaction every-

* A Paper read at the Conference of the Society of Arts on Water upply. Held at the International Health Exhibition, July 14th and 5th.

where of life and the conditions of living, we can scarcely doubt that the actual mixed substance, water, is better suited to supply the wants of our daily life than the ideal unmixed substance would be; and, further, we have no reason whatever to look upon this ideal substance as furnishing a standard of excellence, to which it is desirable that our daily supply should, as far as practicable, and in all respects, approximate. What we really desiderate is not chemical purity, but hygienic freedom from anything hurtful. In some water, as in some air, an objectionable constituent may be met with; but in the case neither of water nor air is there any presumption on the score of wholesomeness, in favour of a single substance as such, rather than of a mixed substance as such. The presumption is indeed the other way. No one desires unmixed oxygen, or even oxygen and nitrogen free from commixture with the minor constituents of our native air; so neither is there any reason to desire unmixed protoxide of hydrogen, freed from the minor constituents of wholesome natural water. It is clearly open to a chemist, addressing himself to chemists, to speak of the constituents of ordinary water, other than protoxide of hydrogen, as impurities in the water; provided of course that he is consistent, and includes the desirable dissolved gases of the water among its impurities and as contributories of the sum total of its impurity. It is also open to a chemist, addressing himself to chemists, to make a comparison of different natural waters in respect to the relative proportions of their total impurity, or of their saline impurity, or of their calcareous impurity, or of their organic impurity, or of their aërial impurity, &c. But it is not, I take it, open to a chemist, addressing the general public, to speak as a chemist of some particular selected constituent, characteristic of the class of natural waters derived from one kind of source, as an impurity, and to leave it to be inferred by the general public that because this constituent is, in a strict chemical sense, an impurity, it is therefore a something nasty and unwholesome, and that the class of waters in which it is more especially met with are, in proportion to the extent of its presence, nasty and unwholesome. The general public do not know that the chemical impurity of a water may be good or bad, noxious or innoxious, desirable or undesirable, wholesome or unwholesome. They are unaware that no scale of wholesomeness or desirableness can be inferred from a scale of chemical purity, with respect to some particular constituent stigmatised as an impurity, until it has been established by evidence that this particular chemical impurity is of an unwholesome or prejudicial character. It is a mere dialectic artifice, and not a very worthy artifice, to use the word impurity in a strictly scientific sense, with intention to have it accepted in a popular sense as bearing a meaning which, scientifically, by no means belongs to it.

III. *Organic Matter of Water.*

The saline matter of water is a useful expression to denote the sum of the dissolved mineral constituents, and the organic matter of water a useful expression to denote the sum of the dissolved organic constituents of natural water. The saline matter of one water is not necessarily, or yet commonly, identical with the saline matter of another water; nor is the saline matter of the selfsame body of water necessarily identical throughout its entire extent, or from one period of time to another. The same holds good with regard to the organic matter of water. It is a different thing in one water from what it is in another; and may be different in the same water from place to place and from time to time. But just as there is a character or nature more or less common to the usual varieties of dissolved saline matter, so also is there a character or nature common, within certain limits, to the usual varieties of organic matter met with in potable water. So far, a certain parallelism holds good between the saline matter of water on the one hand, and its dissolved organic matter on the other. But in many important particulars the parallelism fails. Thus the saline matter occurs, for the most part, in appreciable proportion, say from $\frac{1}{10}$ to $\frac{1}{10}$ of a per cent. It is constituted of definite chemical substances, possessed of well-determined properties; and its amount is capable of estimation with all desirable accuracy—with considerable accuracy by direct weighing, and with yet greater accuracy indirectly, by the separate estimation of its several constituents. The dissolved organic matter of potable water, on the other hand, never amounts to more than an exceedingly minute proportion, say from $\frac{1}{10}$ to $\frac{1}{10}$ of a per cent; what are its separate constituents, and what their chemical nature, is almost if not wholly unknown; its amount is, moreover, incapable of direct determination, and the different means for its indirect determination are far from satisfactory. Chemists are capable, however, thanks to Dr. Frankland, of determining with a considerable degree of accuracy the quantity of carbon that exists in any water, in the form of organic matter. Evidently, if all organic matter contained the same proportion of carbon, a determination of the organic carbon present in any water would be tantamount to a determination of its organic matter. But in reality, the proportion of carbon existing in different individual varieties of organic matter has, on the contrary, a very wide range of variation. Still, it would appear, from such imperfect investigations as have been made, that the proportion of carbon existing in the organic matter of water—that is to say, the mean proportion of carbon present in the whole of the several individual constituents of the organic matter taken together—is not subject to any such considerable range of variation, and that it may, without risk of serious error, be valued at about 40 per cent. Disregarding then for the moment the consideration of the nature of the dissolved organic matter present in natural water, and confining attention only to its quantity, it may be taken as admitted that the determination of the organic carbon in water is an absolute, and more than fairly accurate, determination; that the organic matter of water is in a general way proportionate to the amount of its organic carbon; that the amount of organic matter may accordingly be represented by some multiple of the organic carbon; and that for purposes of comparison, at any rate, this multiple may be taken provisionally as 2·5, corresponding, of course, to the occurrence of 40 per cent of carbon in the organic matter.

The inquiry next presents itself as to what, on the basis of these propositions, is the quantity of organic carbon, and consequently of organic matter, present in the three classes of water derived respectively from each of our typical varieties of source. Speaking generally, it may be said that the proportion of organic matter is decidedly least in spring or well water—that is to say, if we limit our attention to such waters only as would be taken for town supply, for there are, of course, foul well waters, in which the amount of organic matter is in excess of anything ordinarily met with in the water of lakes and natural rivers. As between lake sources in general, and river sources in general, it is not easy to assign the order of seriation. The proportion of organic matter found in different lake waters is, on the whole, more uniform than the proportion found in the waters of different rivers. Accordingly, while in some river waters the proportion of organic matter is somewhat higher, there are other river waters in which it is very considerably lower than the proportion commonly present in lake water. On the whole, it would seem that river water in general must take precedence of lake water in respect to the smallness of its proportion of dissolved organic matter, subject, however, to the observation that the proportion of this constituent is more variable in river water; or that it is liable to a greater range of variation, both as between the water of one river, and the water of another, and as between the water of the same river at different seasons. In order to give some idea of the quantities of organic carbon, and consequently of organic matter, present in the water, furnished from different varieties of source for town supply, I have made an abstract of the results set forth in the Registrar-General's monthly

Mean of Eighteen Monthly Analyses.

Source.	Proprietary.	Organic Carbon. Parts per 100,000.	Organic Carbon. Grains per gallon.	Organic Matter. Grains per gallon. (estimated.)
Chalk Springs..	Kent Company	0·047	0·033	0·083
River Lea and Springs	New River Company	0·089	0·062	0·156
Mixed	Birmingham Corporation ..	0·132	0·093	0·231
River Lea..	East London Company . ..	0·139	0·098	0·245
Loch Katrine	Glasgow Corporation	0·147	0·103	0·257
River Thames..	The Five Companies	0·164	0·115	0·286

reports for the last year and a-half, beginning, that is to say, with the report for January, 1883, and ending with the report last made, for June, 1884, in respect to the supplies of London, Birmingham, and Glasgow. I have resorted to the reports of the Registrar-General, in part, because they alone furnish the results of a regular series of analyses of the water supplied to other towns than London; and, in part, because, with regard to London, I have, for the purpose of this address, preferred to bring before you the results of analyses for which I am not in any way responsible. There is not, however, any appreciable difference between the mean results for the period obtained by Dr. Frankland, on the one hand, and by my colleagues and myself on the other, in respect to the composition of the London waters examined by both of us.

The five Thames waterworks companies, as is well known, take their supply from the river at Hampton, Ditton, and Molesey. They furnish just under 50 per cent of the total supply of the metropolis. The East London Waterworks Company take their supply from the River Lea, some distance below Ware. Their subsiding reservoir at Walthamstow has the enormous area of 222 acres, equal to that of a good-sized lake. The company have power to take in addition ten million gallons of water daily from the Thames at Sudbury. It is but seldom, however, thet they resort to the Thames at all; and very rarely indeed to the extent of more than one-quarter of the daily amount they are privileged to obtain. Substantially, the water of the East London Company is water from the Lea. The New River Company takes somewhere about four-fifths of their supply from the Lea, above Ware, and the remaining one-fifth from Chadwell springs and a series of deep wells sunk in the chalk. The East London and New River Companies jointly, furnish about 44 per cent of the total supply of the metropolis. The Kent Waterworks Company take their water entirely from deep wells in the chalk, and furnish from this source rather more than 6 per cent of the total supply of the metropolis. The water supplied to the town of Birmingham by the Corporation is taken from various sources, lake or reservoir, stream, and well, but in what relative proportions I am unable to say. The water supplied to the town of Glasgow by the Corporation is taken, as is well known, from Loch Katrine. The subjoined table shows the actual quantities of organic carbon, expressed both in parts per 100,000 and in grains per gallon, and the estimated quantities of organic matter in grains per gallon, present in these six several supplies of water, as determined by monthly analyses of the waters conducted during the last year and a-half.

It will be seen that the organic matter of the Kent Company's water, which is a spring-water, is under one-tenth of a grain per gallon; that the organic matter of the New River Company's water, which is mainly a river-water, is considerably under two-tenths of a grain per gallon; that the organic matter of the East London Company's water, which is a river-water, that of the Birmingham Corporation's water, which is a mixed water, and that of the Glasgow Corporation's water, which is a lake-water, are alike about two and a-half tenths, *i.e.*, a quarter, of a grain per gallon; while the organic matter of the Thames Companies' supply of river-water is under three-tenths of a grain per gallon. It is to be noted however, that, although the average proportion of organic matter in the Thames-derived water supplied to London, is a little in excess of that in the Birmingham and Glasgow Corporations' supplies, the excess is entirely due to the effect of the winter floods. Comparing the results in the summer nine months, March to September, 1883, and March to June, 1884, the proportion of organic matter in the Glasgow Corporation's supply is somewhat in excess of the proportion found in the Thames supply, the number of grains of organic matter being for the Thames-derived water 0·22, and for the Glasgow water 0·25 grain per gallon. Similarly, the organic matter of the East London Company's water, during the summer months, falls appreciably below that of the Glasgow Corporation's supply at the same season of the year—the season, that is to say, during which a high character of water is considered to be more especially demanded. The above statements, as to the particular fractions of a grain of organic matter ordinarily present in a gallon of different kinds of water, serve to convey some idea of the always exceeding smallness of the quantity. A better notion, however, of the minuteness of even the highest proportions of organic matter found, say, in any London water, is afforded by stating the results in another way. Thus, if we suppose for an instant that the Thames companies' water, instead of containing under three-tenths of a grain, contained seven-tenths of a grain of organic matter per gallon—a maximum which has been occasionally approached in the supply of one or other of the Thames companies at a period of flood—even this exceptional proportion would but correspond to the presence in the water of exactly the thousandth part of 1 per cent of organic matter. Whether or not, variations within the limit of such a small proportion of dissolved organic matter present in potable water, ranging from about the one-thousandth part of 1 per cent exceptionally met with in a Thames-derived water, down to the eight-thousandth part of 1 per cent habitually met with in a chalk spring-water, are matters of any real significance, must obviously depend on the character of the dissolved organic matter present in the different waters. It will suffice for the present to observe that, so far as mere quantity of organic matter is concerned, the water supplied to London from the Thames and Lea takes, on the whole, precedence of the highly reputed, and deservedly reputed, water furnished to Glasgow; as, doubtless, it will take precedence of the water about to be furnished to Manchester.

As regards range of variation, it is noticeable that, while the mean proportion of organic matter present in the summer supply of the Thames Companies, as calulated from the average of forty-five analyses reported to the Registrar-General, is 0·22 grain per gallon; and the mean proportion present in the yearly supply, as calculated from the average of ninety analyses, is 0·28 grain per gallon; the proportion in one particular sample of water out of the ninety samples analysed fell to 0·17 grain, in two samples it rose to 0·50 grain, in one sample to 0·53 grain, and in yet another sample to 0·60 grain; but that in no one sample out of the ninety did it reach the maximum of 0·70 grain per gallon, so as to constitute the thousandth part of 1 per cent of the water. It happens similarly in nearly all natural waters, that while the absolute variation in the proportion of organic matter present at different

times is almost infinitesimally small, the relative variation is, on the other hand, strikingly large. Thus the proportion of organic matter present in the Glasgow Corporation's lake-water at different times varies as 1 to 2; that in the Kent Company's spring-water, in the East London Company's water, and in the Thames Companies' water, varies as 1 to 3 or 3½; that in the New River Company's water varies as 1 to 4; and that in the Birmingham Corporation's water varies as 1 to 7; but the larger range of variation in the water of these last two supplies is dependent, doubtless, on the circumstance of their being mixed supplies, constituted of unequal proportions of their several contributories at different times. In the official phraseology with which we are so familiar—phraseology of but little meaning, though the words are strong—it would be said that while the degree of "pollution by organic impurity" of the Glasgow water is twice as great at one time as at another, the degree of "pollution by organic impurity" of the Birmingham water is seven times as great at one time as at another. The large extent of relative variation thus noticeable in respect to the organic matter of water is common, as might be expected, to those other of its constituents, which also exist absolutely in very small quantity, and is, indeed, almost a consequence of the smallness of their absolute quantity. A somewhat parallel comparison may be adduced in the case of personal wealth. We know that while the wealth of a capitalist will, for the most part, vary only by a small percentage from month to month, the whole fortune of a beggar, his utmost riches being a matter of no consideration, may vary many-fold in the course of a day, although by the absolute amount of only a few halfpence put into or taken out of his ragged pocket.

IV. *General Considerations.*

So far, attention has been directed to the organic matter of potable water solely from the point of view of its quantity. A much more important inquiry, however, has reference to its nature or quality. But this is too large and important a matter to be taken up at the fag end of an address, limited strictly to the duration of a short half-hour. That the organic matter of potable water is constituted in the main of dissolved, unorganised, and non-living matter, does not admit of question. Anything like an adequate discussion, however, of the origin, nature, and possible hygienic influence of this main portion of the organic matter could not but involve a very long story. It may suffice here to say that, having regard to its origin and nature, and to the minuteness of its proportion, the presumption against any unwholesomeness attaching to its presence is very strong. To what extent living and organised matter may be also present in potable water; how far such living organic matter may include a something capable of developing zymotic disease; and, admitting all this, how far the liability of different waters to contain more or less of noxious living organic matter is related to the varying amounts which they contain of innoxious non-living organic matter, are questions far more difficult of solution. They are questions on which, in the present imperfect state of our knowledge on the subject, it behoves every one to speak with caution; but in my own view, having regard to what is observed and recorded respecting the health of differently supplied populations, and to what little is known of the natural history of disease-producing organisms, the preponderance of evidence does not, I think, favour an alarmful answer. Other persons, however, are of a different opinion. But the address which I have been asked to read at this Conference is on the chemistry of potable water; and my concern to-day is solely with the chemical aspect of the subject. It is not from biologic or pathogenetic inquiries, but from the results of the chemical analysis of the water supply to London—from the mere determinations of the quantity of its organic matter—that its wholesomeness is month after month, by suggestion, impugned. On this point I join issue altogether. Further, it seems to me an abuse of chemistry, that a chemist, who on other than chemical grounds may, rightly or wrongly, have satisfied himself of the unwholesome of a particular water supply, should state and summarise the results of his analyses in such a fashion as to make it appear that the unwholesomeness, which he really infers on other grounds, is deducible from the results of his periodical chemical examinations. It is well understood that a statement, of which the verbal accuracy cannot be challenged, may, nevertheless, be far from a warrantable statement. It may convey a *suggestio falsi*, and include a *suppressio veri*. Such I take to be the case with the statement, paraded month after month, in what is an official, and should be a scrupulously impartial, report, as to the relative "amounts of organic impurity" contained in individual samples of metropolitan water, compared with a particular decennial average amount present in the Kent Company's water,—a standard, by the bye, of which the value is known and used only by the reporter, whose comparison, accordingly, it is impossible to check. This monthly statement suggests, I take it, the notion that spring-water is the proper type of what river-water, or at any rate of what metropolitan water, should be—a notion entirely without foundation, and discordant with the reporter's own strong recommendation of lake-water for the supply of London. It further suggests the notion that the desirableness and general wholesomeness of different waters are inversely proportional to their relative "amounts of organic impurity," irrespective of the origin and nature of this so-called impurity,—a notion equally devoid of foundation. On the other hand, the statement in question suppresses the fact that spring-water, lake-water, and river-water, have each their special characteristics, excellences, and defects. It suppresses the fact that the so-called "previous sewage contamination" of the standard spring-water is as relatively high as its "amount of organic impurity" is relatively low. It suppresses the fact that the "amount of organic impurity" in the metropolitan river supply, though threefold or fourfold that present in the spring water supply, is nevertheless almost infinitesimal in absolute quantity. It suppresses the fact that the "amount of organic impurity" in the highly reputed Loch Katrine supply is, during the summer months, in excess of, and is on the average of the year substantially identical with, the summer and yearly amounts respectively present in the metropolitan river supply. It further suppresses the fact that the head waters of the Thames, by the time they reach Lechlade, about 22 miles only from their source, and about 120 miles above the Companies' intake, have exchanged their character of spring water for that of river water, and irrespective of urban contamination, contain an "amount of organic impurity" identical in quantity with, and chemically undistinguishable in kind from, that met with in the river water at Hampton. I dispute altogether the notion suggested by the mode of statement adopted in the monthly reports made to the Registrar-General, that the relative unwholesomeness of the Kent Company's water, the New River Company's water, and the Birmingham Corporation's water, was, during the last eighteen months, approximately as the numbers 1, 2, and 3; or, in other words, that it was in the proportion of the 8-hundredths, the 15-hundredths, and the 23-hundredths, of a grain of dissolved organic matter per gallon, present in the three supplies respectively. I contend, further, that the New River Company's water would have been no more wholesome or unwholesome respectively, if, instead of actually containing 15-hundredths of a grain of organic matter per gallon—this organic matter being chiefly of vegetable origin, and a product of ordinary fluviatile life—it had contained, like the Kent Company's water, as little as 8-hundredths of a grain, or, like the Birmingham Corporation's water, as much as 23-hundredths of a grain of organic matter, the absolute variations of a tenth of a grain or so of such

dissolved organic matter per gallon, being too small to have any real hygienic importance whatever.

If it were indeed the fact that the dissolved organic matter of potable water, taken as a whole, is of such a nature that, in the proportions in which it is met with, it is capable, on occasions, of developing and spreading epidemic disease, it is manifest that no plea, based on the actual smallness of its proportion, would be of any avail to save it from hopeless condemnation. It is manifest also, on this assumption, that the determination of the variations in the proportions of organic matter present in a water, notwithstanding the minuteness of even the maximum proportion, would be a determination of the highest significance; and further, that any information furnished in intelligible language to the general public, as to the results of a comparison of different waters with one another in regard to their respective proportions of organic matter, would have an extreme degree of interest and value. But all this is based on the hypothesis that the dissolved organic matter of water, or at any rate the dissolved organic matter of some water, taken in its entirety, is a noxious constituent of the water, capable, in proportion to its quantity, of setting up epidemic disease; a view, it need scarcely be said, which is sustained by no sort of evidence, and supported by no weight of authority. If, indeed, the organic matter of water were really of this noxious character, the conclusions above set forth, with regard to the propriety and value of a comparison of waters with one another in respect to so noxious a constituent, would be undeniable. But if, on the other hand, the minute proportion of dissolved organic matter met with in potable water is constituted mainly of innocuous vegetable extractive, with a trace or more of innocuous animal extractive; and if, at the same time, this organic matter does not affect in any appreciable degree the taste, or colour, or appearance of the water, clearly all variations in the amounts present in potable water, that fall within the limits of an exceedingly minute proportion, are matters of no consideration whatever; and this whether they be variations in the proportions existing in different waters, or variations met with in the same water at different times. And the same conclusion would hold good, even if the organic matter of water, while constituted in the main and at most times wholly, of innocuous extractive, was, nevertheless, liable to include at other times a sub-proportion of an effectively noxious agent; unless, indeed, it could be shown that the liability of different waters to contain this noxious agent was in proportion to their relative amounts of dissolved organic matter—a proposition so preposterous as never to have been seriously put forward. Whether or not there exist any good grounds for calling in question the excellence and wholesomeness of the water, supplied to probably the healthiest great city in the world, is another matter. Speaking as a chemist, I represent that there are no chemical grounds for such a contention. In support of this position, I would call to mind that the last Royal Commission on Water Supply, after hearing very varied evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial; and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial. Their conclusion on the general question is expressed in the following words:—"Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the companies is not generally good and wholesome."

Action of Water and Nitric Acid upon Basic Telluric Nitrate.—MM. Klein and J. Morel.—The basic telluric nitrate behaves nearly like the nitrates already known as decomposable by water, *e. g.* that of bismuth. There is not, however, formed a basic sub-salt or a hydroxide, but tellurous anhydride.—*Comptes Rendus*, No. 14.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XIII.

Communicated by F. P. DUNNINGTON,
Acting Professor of General and Analytical Chemistry.

I MUST acknowledge my obligations to Mr. W. G. Brown for the efficient aid given me in directing much of the following work.—F. P. D.

(104). *Examination of Blue Quartz from Nelson Co., Va.* By ROBT. ROBERTSON, of Danville, Va.

Nelson county lies in the belt of country which extends along the eastern slope of the Blue Ridge, is known as the Piedmont region, and is composed of archean rocks. Near the middle of this belt, and also of Nelson county, passes a strip of light-coloured land locally known as the "Kaolin belt." This is from ¾ to 3 miles wide and of undetermined length, and is largely the product of decomposition of a granulitic rock (felspar and quartz). The aggregation of these minerals varies much, the quartz being in some places in small grains and in others forming rather large masses. In some localities the quartz formed a considerable component of the rock, in others but little or none is mixed with the felspar. In all its occurrence, however, the quartz presents a characteristic waxy lustre, and a colour varying from pale to deep blue. It, therefore, appears of interest to ascertain to what this colour is due.

The thin brown films which penetrate this quartz are so numerous that no homogeneous pieces with any dimension exceeding a few centimetres can be obtained, yet the whole forms a firmly coherent mass.

A fragment was fused before the hot-blast blowpipe flame and retained its blue colour. The pulverised mineral was digested in hydrochloric acid to remove all ferric oxide which might exist in these films, and then treated with hydrochloric acid to remove all silica. The analysis presented the following composition:—

Ferric oxide	0·539
Titanic oxide	0·069
Silica (by diff.)	99·392
	100·000

A thin section of the rock was examined under the microscope and found to show throughout the mass a network of extremely thin acicular brown crystals, thus presenting when magnified about 400 diameters an appearance very similiar to that of sagenite to the naked eye. Some of the crystals were twinned, forming the geniculations common with rutile. The angles of these geniculations when lying approximately in the plane of vision measured 70°, 71°, 76°, and 52°, 57°; hence probably identical with the arrangement of the needles in sagenite observed by Dr. A. von Lasaulx in Bonn, being twinned at the angles 65° 35′ and 54° 44′. This thin section is decidedly yellow by transmitted light, also shows the threads of iron above referred to, and by reflected light is blue.

In view of the blue colour of some varieties of titanic oxide, when seen by reflected light, it appears possible that the partial reflection of light by the surfaces of these microscopic crystals occasions the colour in questions, or the latter may be in a measure due to the interference of light occasioned by these crystals.

It is to be noted that this belt of granulitic rocks and the accompanying gneiss frequently show crystalline masses of rutile on the surface, which have weathered out on decomposition. Moreover the magnetic iron ores contained in these rocks show a large amount of titanic oxide.

(105.) *On Argentic Hydrate.* By J. D. Bruce, of Coles Ferry, Va.

In view of the ready decomposition of cupric hydrate by heat, it appeared probable that if a solution of a silver salt was treated with a solution of a soluble hydrate at a low temperature, argentic hydrate might be precipitated and not argentic oxide as at ordinary temperatures.

A dilute solution of silver nitrate in 90 per cent alcohol was prepared, also a similar solution of potassium hydrate. The exact strength of each of these solutions was then ascertained. Portions of each of these solutions containing equivalent amounts of silver nitrate and potassium hydrate were mixed and found to give the usual brown pulverulent precipitate of argentic oxide. Then similar portions of these solutions were put into test-tubes and these cooled to −10° F. by means of hydrochloric acid and snow, one solution poured upon the other and gently shaken; the resulting precipitate was flocculent and light brown. The latter experiment repeated several times, at lowering temperatures, afforded a precipitate with less and less colour.

The most satisfactory experiment was made on a morning when the temperature of the atmosphere was 2° F. Hydrochloric acid was cooled to −28° F. and mixed with an equal weight of freshly-fallen snow in a beaker wrapped with cotton and card board; in this portions of the solutions taken as above were cooled. A thermometer graduated to −40° F. had the alcohol carried considerably below the graduation, showing a temperature of about −50° F. The perfectly clear silver nitrate and potassium hydrate solutions were mixed as before, and the resulting precipitate was flocculent and almost pure white, with perhaps a very slight tinge of brownish red. The precipitate thus obtained assumed colour, as the temperature was increased, so that at −40 F. it was a pale brown, and no attempt to separate the precipitate without alteration succeeded.

Although repeated attempts were afterwards made to repeat these results, the thermometer not falling below 20° F. again during the winter, the exceptionally cold mixture, such as was obtained on the one morning, could not be procured again. In each case, however, the colour of the precipitate more nearly approached pure white, as the temperature approached that which existed in the experiment above described.

So far as is ascertained, argentic hydrate is but slightly soluble in water. The analogies to be drawn from the properties of compounds of mercury, copper, lead, &c., render it exceedingly probable that the white flocculent precipitate above in question was argentic hydrate.

(106.) *Analysis of Amazon Stone from Amelia Co., Va.* By C. C. Page, University of Va.

In the mica mine of Amelia Co. referred to above, the giant granite contains several varieties of felspar; of two forms of this felspar analyses have been made in this laboratory.* In addition to these, an amazon stone is found, which, in the larger crystals, usually shades off to white, but in some crystals of moderate size is of uniform colour. It is light green or bluish green in colour, the lustre of cleavage faces is vitreous to pearly, sp. gr. =2·564.

Analysis afforded the following:—

Silica	64·12
Alumina	16·84
Ferric oxide	2·28
Lime	0·32
Magnesia	0·26
Potash	13·34
Soda	1·88
	99·04

A thin section viewed under the microscope in polarised light gave the characteristic grated structure of microcline, and showed also a slight admixture of a plagioclase.

* Chemical News, Nos. 1197 and 1143.

(107.) *Analysis of Apatite from Amelia Co., Va.* By G. H. Rowan, of Jacksonville, Ala.

In a vein of coarse granite about a mile from Amelia, C. H. Va., from which large sheets of mica are obtained for commercial purposes, and in which the rare mineral microlite has been found* along with brilliantly phosphorescent fluorspar, columbite, helvite, beryl, and monazite†; there also occurs sparingly, imbedded in felspar, apatite of the following character.

It is in translucent white crystals, with a shade of violet, being cracked in various directions, laminated parallel to i 2, of vitreous lustre, and quite fragile. On heating, it phosphoresces with a yellow light. The following crystalline faces were identified.—

O, I, i 2, 1, 2, 2 −2 (Dana.)

Sp. gr. = 3·161. Analysis gave:—

Lime	53·94
Alumina	0·19
Ferride oxide	0·81
Phosphoric oxide	41·06
Fluorine	3·30
Chlorine	trace
Loss by ignition	0·81
Insoluble residue	0·63
	100·72
Deduct O, replaced by fluorine	1 39
Total	99·33

Corresponding to the formula—$Ca_3P_2O_8 + \frac{1}{3}CaF_2$.

The insoluble residue was probably due to adhering mica.

(108.) *Analysis of Albite from Amelia Co, Va.* By Robt Robertson.

This is another of the varieties of felspar referred to in the preceeding article It is found in occasional small crystalline masses, within masses of albite, having a bluish grey colour with slight opalescence and the colours of labradorite. Cleavage on O pearly and regularly striated, and on i ī pearly. Sp. gr. = 2·618.

Analysis gave the following:—

		Oxygen ratio.
Silica	67·06	768
Alumina	21·72	216
Lime	1·59	10
Magnesia	0·03	
Soda	10·01	57
Potash	0·39	
	100·83	

Which approximates to the composition of six molecules of albite mixed with one molecule of anorthite.

(109.) *On the Action of Sulphuretted Hydrogen upon Metallic Silver.* By J. M. Cabell, of Richmond, Va.

I. A piece of pure silver, cleaned by aid of borax, potassium cyanide, and water, was heated within a glass-tube, hammered between polished steel to a rectangular form, put into a thin glass bulbed tube, heated gently, and dry air passed over it; the silver was then sealed within the bulb.

Sulphuretted hydrogen generated from golden sulphide of antimony and hydrochloric acid was passed successively through water, 24 inches of dried calcium chloride, 4 inches of phosphoric anhydride, then through a 2 foot tube containing in its middle the above thin bulb with the silver,

* For a more complete description of this locality see *Amer. Journ. of Science*, vol. xxv., May, 1883.

† *Amer. Chem. Journ.*, May, 1881, p. 130.

and at each end 3 inches of phosphoric anhydride, confined by plugs of cotton-wool; from this the gas passed through 4 inches of phosphoric anhydride, 16 inches of dried calcium chloride, and into a jar of lime.

A slow current of sulphuretted hydrogen was passed as above for three hours, then by jarring the tube the thin bulb containing the silver was broken, the current continued for forty-five minutes, and then the 2-foot tube sealed so as to leave the silver still confined between the layers of phosphoric anhydride. In twelve hours the silver was slightly tarnished (the phosphoric anhydride, however, showed evidences of some moisture). After three weeks it was considerably tarnished.

II. A second experiment was conducted as before, except that the silver was not hammered but quite rough, and glass-wool was used in place of cotton, to confine the phosphoric anhydride. In twelve hours the silver had turned quite dark, and the phosphoric anhydride showed evidence of more moisture than it did in the previous experiment.

III. In a third experiment, the silver was hammered as in I., and then polished bright. It was then (not sealed in a bulb) put in a 2-foot tube between the layers of phosphoric anhydride, confined by glass-wool. Then hydrogen was passed successively through an acid solution of potassium permanganate, potassium hydrate, sulphuric acid, 2 feet of dried calcium chloride, 4 inches of phosphoric anhydride, and then through the tube with the piece of silver arranged as above; this continued for an hour, while the latter tube was gently heated. Sulphuretted hydrogen was then passed through the apparatus for three hours, and the 2-foot tube sealed. After twenty-four hours the flat polished surface of the silver remained bright, but the edges were slightly tarnished. The silver was then heated to about 150° C., and it was darkened.

IV. In a fourth experiment, the silver was prepared and arranged as in III., the posterior portion of the apparatus was connected with a Sprengel air-pump in place of the jar of of lime, and the anterior end closed. The whole, including both the calcium chloride tubes, was exhausted, and then pure dry hydrogen let slowly in; the whole again exhausted, and the silver gently heated for fifteen minutes. While thus heating the silver, which was within a soft glass tube, the former was blistered (at a temperature considerably below a red-heat) and the polish of the surface, to some extent, destroyed. After removing the heat, hydrogen was again let in and passed through the apparatus for seventy-five minutes; in the course of this the silver was heated for ten minutes. Sulphuretted hydrogen was then passed through and the tube sealed as before. After four months at summer temperature the edges of the silver which were not so well polished were slightly acted upon, while the main portion of the surface presented no change in appearance.

From the above we may infer that, in absence of water, silver does not decompose sulphuretted hydrogen at the common temperatures.

(110.) *Analysis of Cassiterite from King Co., N.C.* By J. D. Bruce.

Through the kindness of Dr. C. W. Dabney, of Raleigh, N.C., I obtained this specimen from the deposit of tin ore recently discovered. While numerous assays of this ore have been made, I am not aware of any full analysis. The portion examined is of resinous lustre, transparent, and of light brown colour. Sp. gr. = 6·956.

According to a method recently suggested,* the powdered mineral was gently heated within a glass tube, and dry hydrogen passed over it, the residue, consisting mainly of metallic tin, was digested in hydrochloric acid, the insoluble residue filtered off, the tin precipitated as stannous sulphide, and the filtrate treated in the usual manner. The analysis gave the following composition:—

Stannic oxide	95·176
Ferric oxide	1·455
Lime	0·277
Magnesia	0·020
Water (loss by ignition)	0·218
Insoluble residue	2·841
	99·987

The insoluble residue was probably in the main silica. Another analysis afforded almost identical results.

(111.) *Analysis of Pinite from Madison Co., N.C.* By Chas. L. Reese, of Baltimore, Md.

This mineral is found in the Smoky Mountain near the Warm Springs, N.C., and is sold at the latter place in the form of cuff buttons and similar articles. It is amorphous, white with tinge of green, translucent, has waxy lustre, rough fracture, with greasy feel, and is found in irregular masses. Hardness = nearly 3; sp. gr. = 2·822.

The average of two concording analyses by Mr. Reese gave results, A. I append also an analysis of this mineral from the same locality by Mr. C. H. Slaytor, F.C.S., made in Prof. Bunsen's laboratory in Heidelberg (see B).

	A. (C.L.R.)	B. (C.H.S.)
Silica	47·28	47·31
Alumina	36·47	38·11
Lime	0·28	—
Magnesia	trace	—
Potash	11·40	13·37
Soda	0·74	—
Water	4·39	1·05
	100·56	99·84

The oxygen ratio for bases, silica, and water = 3 : 4 : $\frac{3}{4}$, varying somewhat from the typical oxygen ratio 3 : 4 : 1, as do so many specimens of this species.

(112.) *On Crystallised Phosphorus Anhydride.* By J. M. Cabell.

Phosphorus was burned with a limited supply of air, the white flakes allowed to settle, and quickly transferred to a glass bottle. Hydrogen was passed successively through an acid solution of potassic permanganate, potassium hydrate, sulphuric acid, 2 feet of dried calcium chloride, and then into a 2-foot tube, of which the first and last 6 inches were filled with the above mixture of oxides of phosphorus, confined by glass-wool; the intervening space was left empty. The current of hydrogen was passed for some minutes, and then the anterior portion of the oxides of phosphorus gently heated. When the temperature rose to about 350° F. crystals began to deposit on the sides of the empty portion of the tube, while the residue became semi-fused. No measurements of these crystals could be made, but they were apparently mono-clinic, showing the forces of the base and prism and the pinacoids. The tube was then broken, and the crystals were quickly transferred to litmus-paper, which they did not redden for some seconds, the aqueous solution gave no reaction for phosphoric acid with ammonium molybdate, and none with magnesia mixture. After warming it with nitric acid it gave both the above reactions for phosphoric acid. It is therefore inferred that these crystals consisted of phosphorous anhydride.

(113.) *Analysis of Chrysocolla* (?) *from Gila Co., Arizona.* By Robt. Robertson.

This specimen was received at the Baltimore Copper Works in a lot of ore from the Old Dominion Copper Mine, near Globe, Arizona.

It consists mainly of coal-black particles united by a much smaller amount of bright bluish green chrysocolla, which appears to have filled up the interstices of a loose

* *Zeit. fur Kryst. Becke*, vol. II., p. 318.

pile of fragments of the former. The dark portion is amorphous, of a purple-black colour, opaque, with lustre from sub-metallic to dull; fracture rough, with tendency to conchoidal; streak grey; hardness = 3. Sp. gr. = 2·04.

Analysis afforded the following:—

Silica	31·58
Cupric oxide	30·28
Alumina	6·27
Ferric oxide	0·84
Water	28·71
Manganese oxide (Mn_2O_3)	2·22
	99·90

Neglecting the Mn_2O_3 and Fe_2O_3 as most probably uncombined, we have the oxygen ratio—

$$SiO_2 : CuO : Al_2O_3 : H_2O = 105 : 39 : 18 : 159$$

Hence we have the formula for asperolite, $CuSiO_3 + 3H_2O$, with one-third of the copper replaced by an equivalent amount of alumina. It is to be noted that there is undoubtedly no free cupric oxide, and yet the small amount of oxides of manganese and iron suffice to impart a black colour.

(To be continued.)

VISCOSITY OF OILS.

By W. P. MASON.

As is well known, lubricating oils are rated by their viscosity, the degree of viscosity being fixed by determining the rapidity of flow through a small orifice, and then comparing the same with the rate of flow of rape-seed oil.

The problem is a simple one, yet very widespread dissatisfaction exists regarding results. Oil has been repeatedly shipped as "full test," returned on account of too low viscosity, and, upon being re-tested at the shipping point, found to vary widely from the original figures.

The difficulty lies in the fact that the conditions under which tests are made are seldom twice alike. It is greatly to be doubted if the following questions are often asked:—"What were the dimensions of the containing vessel, the nozzle (if one were used), and the orifice? and of what material were the first two made? At what temperature was the oil during the experiment? what was its specific gravity? what head was used? and was any change of head allowed for on account of variation in specific gravity?"

Overlooking such vital points cannot fail to produce total confusion.

With a view towards obtaining results referred to some definite standard, and therefore comparable, the following viscosimeter is suggested:—

A glass cylinder, twenty-two inches long and one and a-quarter inches in diameter, is fitted to a brass bottom one-eighth of an inch in thickness. Through the centre of the brass plate a hole is bored, one thirty-second of an inch in diameter, and from the lower and outside surface the metal is bevelled away from the hole a half-inch or more. We have thus practically an orifice in a thin plate. Eighteen inches above the plane of the orifice the cylinder is marked with a heavy line (the standard head), and between the sixteen and twenty-one inch points graduation marks are etched an eighth of an inch apart.

In using this instrument all readings are compared with distilled water at 15·5° C. (60° F.), as being something far more definite than rape-seed oil. The water head is taken at eighteen inches, and the quantity of flow limited to 100 c.c. The desired head is maintained by supplying the liquid from a separatory funnel or other vessel provided with a stopcock.

To take the viscosity of an oil:—See that the temperature be normal; take the specific gravity, and therefrom calculate what the head should be to equal eighteen inches of water (it will, of course, be inversely as the specific gravity). Fill to and maintain the calculated head. Determine the time required to fill the 100 c.c. vessel, and divide this time by that required to fill the same vessel with water under standard conditions.

An instrument such as the above has been constructed and used in this laboratory with excellent results.

Troy, N.Y., Oct. 14, 1884.

A METHOD OF TESTING FOR IODINE IN THE PRESENCE OF LARGE QUANTITIES OF BROMINE.

By PHILIP S. BRITO, M.B., late Demonstrator of Anatomy, Aberdeen University, and Science Student, University of Edinburgh.

When engaged in analytical work in the Chemical Laboratory of the University of Edinburgh I discovered the method of testing for traces of I. In the ordinary process of analysis, from a solution supposed to contain Br or I, we liberate the halogen by the aid of small quantities of chlorine, and carry it down with chloroform. The violet colour of I, or the dark sherry-brown of Br, picks out the element. But in a mixture containing both the colour of the less abundant halogen is masked. When I preponderates it is got rid of by the addition of $CuSO_4$ and H_2SO_3. When, however, the Br is in very great quantity, I find that the addition of a crystal or two of $FeSO_4$ completely decolourises the brown colour, and renders visible the minutest traces of I dissolved by the chloroform. The value of this test may be gathered from the fact that in the KBr supplied as a reagent in the laboratory, and which is supposed to be pure, the application of the $FeSO_4$ crystals demonstrates the existence of a trace of I as an impurity. Further, when the colour alone is not decisive, and any doubt exists, its application will settle the point. The behaviour of the Br is probably due to the oxidising power it possesses in common with its sister Cl. How far the decolourisation can be taken advantage of to determine volumetrically the amount of Br in a given exercise can be settled by actual experimentation. However, the ferrous sulphate method when used as a qualitative test works well, and my fellow students and I have never found it to fail, so that although it transpires that the method is not new, yet if this contribution succeed in directing attention to it I shall have done some slight service towards the furtherance of chemical knowledge.

ON THE DETERMINATION OF IRON AND CHROMIUM IN ALLOYS.

By H. PETERSON.

The author's method depends upon the fact that chromium sulphate in a sulphuric solution is oxidised to chromic acid on boiling with potassium permanganate. Half a gramme of the finely comminuted alloy is boiled in a covered beaker with 35 c.c. of dilute sulphuric acid, and dissolved. The solution, if it contains soluble hydrocarbons, is then mixed with a saturated solution of permanganate. When this has been done the ferric salt formed is reduced with zinc, diluted to 1 litre, and the iron is titrated with permanganate. When the titration is completed the liquid is heated to a boil and permanganate (1 c.c. = 0·01 grm. Fe) is dropped in from a burette until there appears a plentiful deposit of MnO_2, which indicates the end of the reaction. MnO_2 is formed by the action of permanganate upon manganous sulphate after all the chromic oxide has been

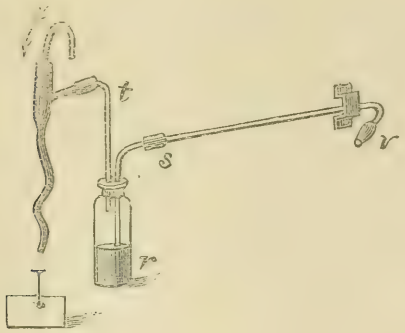
oxidised. The mixture is then poured upon a large filter, the precipitate is well washed with hot water and allowed to cool. The chromic acid in solution is then titrated by adding ammonium ferrous sulphate in excess and titrating back. If merely the determination of the chrome is required the case is much simplified. It is neither necessary to destroy the hydrocarbons nor to dilute so largely. —*Chemiker Zeitung, Gœthen.*

TO REMOVE NOXIOUS VAPOURS IN THE EVAPORATION OF CORROSIVE LIQUIDS.

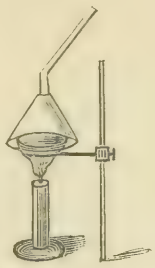
By Le R. C. COOLEY.

In the chemical laboratory of Vassar College, a Richards aspirator with the necessary water supply and waste pipes is furnished to every student. It is used not only for rapid filtration, but in other processes wherever a current of air is needed. I have also applied it to the process of evsporation, first, for the purpose of carrying away the noxious vapours arising from corrosive liquids, and second, for evaporation in partial vacuo.

To fit the aspirator for general use it is mounted upon one corner of the student's work-table in the manner shown in Figure 1. A small glass-tube, *t*, joined to the exhaust pipe by rubber tubing, passes through the air-tight cork of an eight-ounce wide-mouth bottle. A larger tube reaches nearly to the bottom of this bottle. The tube *sv* is a little smaller and enters the end of this larger tube, while a piece of rubber tubing stretched over the junction makes a tight but flexible joint. The outer end at *v* has a rubber tube stretched over it, by means of which connection is made with whatever apparatus is to be exhausted. Disconnection is made at this point, *while the aspirator is still running*, to prevent the water from the bottle *r* backing over into the vacuum which has been produced in the filter bottle or other vessel employed.



The Ventilating Funnel.—The stem, 6 or 8 inches long, of a glass funnel, is bent at a right angle near the body. The end of the stem is thrust through the rubber tubing, and into the somwhat larger tube, *v*. The evaporating dish is then brought up under the mouth of the funnel until the funnel rests upon it (Fig. 2). The aspirator is then started and the heat applied. The current of air flowing over the edge of the evaporating dish into the funnel carries the fumes with it to be condensed in the reservoir bottle, *r*, or off with the stream of water into the sink. The edge of the funnel may rest *inside* the evaporating dish with the same result; the same funnel is thus used with dishes of varying diameter. Two sizes are at present in use; one of 3 inches diameter for evaporating dishes, another of 1½ inches for crucibles. The evaporation of acids to dryness is conducted on the open tables without annoyance from their fumes, by means of this simple artifice.



The Flask.—Let the cork of a flask be pierced with two holes, one for a bent tube to enter the aspirator tube, *v*, the other for a straight tube which may be adjusted so that its lower end will be little above the liquid within. A current of air will then pass through this straight tube, over the surface of the corrosive liquid in the flask and sweep its fumes away into the waste.

To evaporate in partial vacuo, provide the flask with a cork carrying the bent tube only. No air can enter, and the aspirator will then create a vacuum, to a degree depending on the head of water at command.—*American Chemical Journal.*

ON ELECTROLYTIC DETERMINATIONS.

By J. WIELAND.

The author has tested the value of the numerous electrolytic determinations which have been proposed, and gives a brief summary of his results:—

Iron, as stated by Classen, can be very satisfactorily determined in an oxalic solution; it is precipitated in a very compact state and of a steel-grey colour.

The determination of manganese in the same manner is less to be recommended. There appears at the negative electrode also a black deposit, which dissolves partially in dilute sulphuric acid with strong effervescence, and is therefore not pure peroxide. The peroxide precipitated even after careful washing still retains potassa. According to Riche, however, the determination of manganese in a sulphuric solution gives good results. The peroxide precipitated according to this method is foliaceous, and is therefore easily washed. A nitric solution cannot be recommended, as in this case a little manganese is always dissolved on filtration.

Classen founds a separation of iron and manganese on the circumstance that in presence of a large excess of ammonium or potassium oxalate the manganese is not deposited until the greater part of the iron has been precipitated, and more than half the ammonium oxalate is decomposed. The author, however, though he carefully followed Classen's instructions, could never succeed in effecting a satisfactory separation, even in presence of a very little manganese. The manganese peroxide which began to be deposited in a very short time contained considerable quantities of iron. As Classen lays down no exact rule as to the strength of the current to be applied, the author carried out a series of experiments with different strengths of currents, from 3 to 8 Bunsen elements (970 to 3170 c.c. of detonating gas hourly). The addition of ammonium and potassium oxalate and the quantities of manganese were modified in various manners

Classen separates iron and aluminium by means of the same reaction. Here the opposite case occurs; we obtain always a few m.grms. iron in excess, as some aluminium is deposited along with the iron at the negative pole.

The separation of lead as such, from an alkaline solution, as recommended by Parodi and Mascazini, cannot be recommended, as the metallic lead very readily becomes oxidised, and its desiccation is therefore attended with much difficulty.

Small quantities of lead, however, can be very satisfactorily separated from a nitric solution, as proposed by Riche. If the quantity is greater (0·6 grm. lead) losses readily occur, as lead peroxide does not adhere firmly to the electrode. The current must not be too powerful.

Cadmium, if acted on by a thermo-battery (yielding hourly 250 c.c. detonating gas = 0·4 ampère) is deposited from an oxalic solution in a very spongy state, and is readily oxidised on drying. If the current is reduced to 0·05 ampère by the introduction of resistances, cadmium in small quantities (up to 0·3 grm.) is deposited in a sufficiently compact state. There was employed as a negative experiment in these experiments a platinum capsule containing about 150 c.c. Cadmium is deposited very well even with stronger currents from a potassium cyanide solution (Beilsten and Jassein), and from a weak sulphuric solution (Luckow, Smith).

The electrolytic determination of bismuth offers great difficulties on account of its tendency to form basic salts and to deposit in a spongy state. With very feeble currents (0·01 to 0·05 ampère) it is practicable to obtain bismuth in a compact state from oxalic and nitric solutions. The precipitation is very tedious.

The author is continuing his researches.—*Berichte der Deutsch. Chem. Gesellschaft.*

THE PRECIPITATION OF GOLD.

If we compare the various processes for the precipitation of gold it appears that the method with ferrous sulphate in an acid solution is simple in execution and complete, provided only the solution is free from chlorine, bromine, nitric acid, and from calcium, magnesium, and sodium hypochlorites. This is not the case with the mother-liquors of chlorination processes which may contain all the above-mentioned bodies. Ferrous chloride has the same effect, but is dear, easily decomposed, and can be conveyed only in vessels of glass or porcelain. The precipitation with hydrogen is more complicated, as a special apparatus and a temperature of 50° to 60° are requisite. It is, however, applicable in all cases, if no copper is present in the solution. The precipitate settles quickly after the reduction of all the oxidised compounds.—*Chemiker Zeitung, Gœthen.*

NOTICES OF BOOKS.

A Guide to the Mineral Gallery of the British Museum (*Natural History*). With an Introduction to the Study of Minerals. Printed by order of the Trustees. 1884.

Guide books to the treasures in our great National Museum can be neither too numerous nor too copious. To be of real service they should be compiled in such a manner that the student may easily find what he desires and the casual visitor gain some scraps of knowledge concerning the objects he is looking at. It would be inexpedient to attempt to suit the requirements of all visitors to this collection by issuing in a single pamphlet information of a technical and popular character combined. A double set of guides or catalogues is essential, and the one before us, drawn up by Mr. Fletcher, is intended for the ordinary visitor to the mineral department, although there is much valuable information that the student will appreciate.

The Introduction to the Study of Minerals, which occupies almost one half of this pamphlet, is a highly interesting chapter, and serves its purpose in an admirable fashion. In it the origin and the growth of the ideas that have made mineralogy, or rather crystallography, a science are well told. Ignoring the indefinite notions about crystals of Gessner, Cæsalpinus and other early writers, a succinct account is given of the great steps that the science made from the measurements by Steno down through those of Romé de l'Isle and Häuy to Mitscherlich. The ideas concerning primative and secondary forms of de l'Isle, the integrant molecules of his contemporary and rival Häuy, and the axial method of representing crystals by the latter's pupil, Weiss, are explained at some length in the simplest language. The relations between optical phenomena and crystalline symmetry, although perhaps of rather a too recondite character for the general reader, have a few paragraphs devoted to them and a short outline in which the classifications that were proposed by Mohr and by Berzelius are explained. We think, however, with all this matter it would have been well to have described more explicitly with the aid of a few diagrams the six (or seven) systems of crystallisation of the text-books, parameters, and the notations of Naumann and of Miller, in a popular way: a few concluding paragraphs on these points might have given this chapter a more definite form.

In a Guide-book intended for the general public we should have liked a little more information relating to the different species,—where and how they are usually found and their associations. The names also of many of the minerals might have received a little explanation; names which to the casual visitor accompanied with this Guide must appear strange, or even with a little knowledge of Latin and Greek, meaningless. Most students will recall some mineralogical fact, however trivial, connected with such names as scolezite, axinite, phenakite, miargyrite, euxenite, automolite or xanthokon, whilst to the popular mind meerschaum and epsomite have meanings of a sort.

Now that the Natural History branches of science have acquired a palace with ample space for themselves there can be little excuse for crowding or throwing these interesting objects together in a higgledy-piggledy manner more apt to weary than instruct the visitor. This little pamphlet shows evidence of reform taking place in several ways, especially in the collections of models of crystals, groups of characteristic minerals to illustrate thermal, optical, and electrical phenomena, colour, taste, hardness, and specific gravity; aiming at making our museum what it ought to be, an educational institution. In the mineral cases themselves we hope soon to see a uniform and complete system of chemical notation used for the students' sake, with the banishment of the Berzelian hieroglyphics that occasionally used to meet the eye.

In Mr. Fletcher's introductory chapter to this guide the young student will find an excellent summary of the history of mineralogy that might be stitched into his Nicol or Dana with advantage.

Report, Port of London Sanitary Committee. With the Half-yearly Report of the Medical Officer of Health for the Port of London. For the Half-year ending 30th June, 1884.

When we consider that annually there are something like twenty-six thousand ships inspected by the sanitary officers of the Port of London, ships from every quarter of the world, of every nationality, bringing all manner of cargoes, from the excrement of birds to the produce of the orchards of Italy, or the spices of the East, we might expect to learn of the importation of many strange diseases. This report, however, contradicts our conjecture, for of the 13,000 vessels inspected during the first six months of the year, only in some six per cent were sanitary defects

noted and remedied, and nine of the vessels only required fumigation.

As regards the cholera epidemic the worst the sanitary officers had to deal with was the burning of the effects, in three instances, of persons who had died of the disease outside the port. The dread of cholera has proved a blessing to the sailor, as he has had, thereby, the cleanliness of his quarters more strictly looked after. Among foul cargoes apparently the worst was amongst ourselves, being a quantity of waste lime from one of our gas-works; the fumes being so bad that "the master and crew had quite lost their eyesight (temporarily), and a woman and two children had been taken ill."

Within the last few years the importation of frozen meat into London has risen and gives prospects of soon assuming vast proportions. "The trade in frozen meat," this report tells us, "is so rapidly growing that its proper treatment has become a very serious question." When we hear of fish by the tons and carcases by the thousands being annually or even monthly destroyed as unfit for human food, surely it is to the discredit of our chemists that nothing can be done to save this valuable commodity.

As for the state of the river in which the vessels float, its lamentable condition is too well known to need description. We read that "it is announced that the Metropolitan Board of Works are intending to attempt to deodorise the river by means of chloride of lime," but that "this will prove a very expensive and unsatisfactory procedure." Now that this extraordinary experiment has been tried, we trust the next report will give full details of the cost and result.

CORRESPONDENCE.

BUTTER ANALYSIS.

To the Editor of the Chemical News.

SIR,—Surely Dr. Leffmann, who writes in the CHEMICAL NEWS, vol. l., p. 192, on the "Results of Some Examinations of Butter," cannot have read Mr. Wanklyn's paper on "the Analysis of Butter" (Society of Public Analysts' Proceedings, March 19), or he would not have credited Mr. Wanklyn with the discovery "that when butter is heated with alcoholic soda butyric ether is given off." This fact has been well known for the last ten years, and has been used ever since as a qualitative test for butter-fat. Mr. Wanklyn merely endeavoured—unsuccessfully in my opinion—to render that simple test a quantitative one.

I would have not thought it worth while to write to you on so small a matter, had not on the subject of the paternity of the various processes of butter analysis now in use most persistent misstatements been made. The odour referred to by Dr. Leffmann was first observed by myself and Mr. Angell, and duly registered in our little treatise on "Butter." So was also the fact that the percentage of insoluble fatty acids in butter-fat is much lower than in other fats. The method which we based upon this difference is in most works, including "Watts's Dictionary," attributed to Dr. Muter. The soluble fatty acids were first accurately determined by Dr. Dupré, but the method described by him is generally credited to Heintz, who, in point of time, took up the subject much later.—I am, &c.,

OTTO HEHNER,
Hon. Secretary Society of Public Analysts.

Trichloric Camphor.—M. P. Cazeneuve.—This compound, $C_{10}H_{13}Cl_3O$ appears in small white crystalline masses, insoluble in water, very soluble in cold alcohol, ether, chloroform, carbon disulphide and all the solvents of camphor; it melts and solidifies at +54°. It belongs apparently to the β series of the chlorinised camphors.—*Comptes Rendus*, No. 15.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 14, October 6, 1884.

Experiments made at Turin and Lanzo on the Distribution of the Electric Light at Great Distances.—M. Tresca.—The total circuit between the Exhibition at Turin, the station at Lanzo, and the intermediate stations measures 80 kilometres. The wire is of chrome bronze, 3·7 millimetres in diameter, and not coated. The installation is perfectly successful.

Nitrates in Plants at Different Periods of Vegetation.—MM. Berthelot and André.—The absolute weight of the nitrates increases up to inflorescence, passes through a minimum, and then increases again, but without reaching the earlier centesimal proportion. At first two-thirds of the potassium exist as nitrate, and finally only one-twelfth.

No. 15, October 13, 1884.

Decomposition of Cupric Oxide by Heat.—MM. Debray and Joannis.—It is generally admitted that the product of this decomposition is an intermediate oxide, a compound of the cupric and the cuprous oxides. The experiments undertaken by the authors show that cupric oxide is split up into cuprous oxide and oxygen, the cuprous oxide remaining simply mixed with undecomposed black oxide, without forming intermediate compounds therewith.

Nitrates in Different Parts of Plants.—MM. Berthelot and André.—Experiments on borage prove that the nitrates are chiefly concentrated in the stem, the principal seat of their formation, which contains both the relative and absolute maximum. The root contains less, which shows that they do not come from the soil, at least in their totality. In the leaf the nitrates tend to disappear, being converted into albumenoid principles in consequence of the reductive actions which are there carried on.

Galvanometer with Astatic Needles.—M. E. Ducretet.—This apparatus cannot be intelligibly described without the accompanying illustration.

No. 16, October 20, 1884.

Alkaline Hydrates. Third Memoir. Hydrates of Potassa and Soda.—E. J. Maumené.—The normal hydrate of potassa was prepared in 1796 by Lowitz, but he did not determine its composition, indicating merely the loss of 43 per cent water of crystallisation. At this time calcined potassa was supposed to be anhydrous. The author exhibited to the Academy crystals containing, when well dried, 50 per cent potassa and 50 of water. He assigns them the formula $(KO)_9(HO)_{47}$. Lowitz indicates another hydrate which contains less water and developes heat when moistened. To 1 KO they contain 3·15 of water. This is a hydrate of the second order. In a third hydrate, described by Walter, the water is reduced to 25 per cent. From the study of the hydrates of baryta, strontia, potassa, and soda, it is permissible to conclude: that the general theory is the only basis for the explanation of chemical action. It destroys the hypothesis of the hydrates MO,HO, upon which rests one of the corner stones of the so-called atomic theory. It frees chemistry from all the hypotheses, all useless for explanation, and all of a nature calculated to injure the intellectual education of the student.

Use of Potassic Manures in Bretagne.—G. Lechartier.—The author shows the importance of potassic manures on soils whose reserve of potash has been exhausted by crops obtained under a prolonged system of phosphatic manuring.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Blowpipe Test for the Calcium Group.—Even the most involatile salts, as the sulphate of Ba, Sr, and Ca, may be detected separately or mixed together by merely heating on very thin platinum wire, say 3 inches to the grain, in a Bunsen flame. In a mixture of the sulphates the calcium flame shows first, then strontium; the barium green is finally seen, and lasts some time. A pocket spectroscope of course aids their detection rendering it more to be relied on. —C. T. BLANSHARD, M.A., F.C.S.

MEETINGS FOR THE WEEK

MONDAY, Nov. 3rd.—Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 8. "Some Points in the Examination of Tallow and some Commercial Oils, especially for Acidity," by W. H. Deering. "On the Processes concerned in the Conversion of Starch into Alcohol, and their Relation to Brewing and Distilling," by W. S. Squire.

THURSDAY, 6th.—Chemical, 8. "On the Vanadates of the Amines," by G. H. Bailey. "On the Action of Aldehyds and Ammonia on Benzil (continued)," by F. R. Japp, Ph.D., and S. C. Hooker. "On Isomeric Modifications of Sodium Sulphate," by Spencer U. Pickering. "Contributions to our Knowledge of Aceto-acetic Ether (Part I.)," by J. William James. "On the Origin of Calcium Thiosulphate," by Dr. Divers. "On Magnesium Hycrosulphite as a Source of Hydrogen Sulphide," by Dr. Divers and T. Shimidzu.

SATURDAY, 8th.—Physical, 3. "On certain Phenomena attending Mixture," by Dr. Guthrie. "On Voltaic and Thermo-Voltaic Constants, by Dr. C. R. Alder Wright and Mr. C. Thompson.

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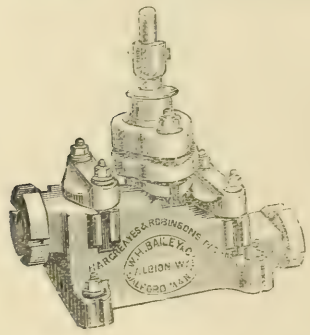

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THE CHEMICAL NEWS.

VOL. L. No. 1302.

THE LITERATURE OF OZONE AND PEROXIDE OF HYDROGEN.

SECOND MEMOIR.

By ALBERT R. LEEDS.

Preface.

AT the meeting of the Chemical Section of the New York Academy of Sciences, held June 12th, 1880, I had the pleasure of presenting to the Academy a first Memoir upon "The Literature of Ozone and Peroxide of Hydrogen." This memoir consisted of four parts. First. A historical and critical essay upon the "Lines of Discovery in the History of Ozone," from the first observation of Schönbein in the year 1840, to the facts made known in the earlier portion of the year 1879. This prefatory essay discussed under separate sections, the original discovery of ozone, its sources and its properties; also the nature of the constituent matter of ozone; finally, the exact nature of the relations existing between ozone and ordinary oxygen.

The second part of the memoir was an "Index to the Literature of Ozone (1785-1879). This memoir was drawn up on the plan suggested by my friend and predecessor as Corresponding Secretary of the Academy, Dr. H. Carrington Bolton. Dr. Bolton has been led, during the course of his classic investigations upon the Fluorides of Uranium (*Berl. Akad. Ber.*, 1866, 299), to prepare for his own more exact knowledge a partial index to the literature of uranium. In the hope of saving future investigators from the great labour of repeating his work, Dr. Bolton completed this Index, and published it in the *Annals of the New York Academy of Sciences*, or as the society was then called, the New York Lyceum of Natural History, vol. ix, Feb., 1870. This first publication was followed by a second (*idem*, xi., Nov., 1875), in which Dr. Bolton has given in the compass of 44 finely printed octavo pages, an "Index to the Literature of Manganese," beginning as far back as the year 1596, and brought down through nearly three centuries, to the year 1874.

His labours prompted Prof. E. J. Hallock to continue the work by preparing an "Index to the Literature of Titanium," (1783-1876), published in *Ann. N. Y. Acad. Sci.*, vol. i., p. 53, Dec., 1876, and Prof. G. J. Rockwell a similar "Index to the Literature of Vanadium" (1801-1876), *idem*, vol. i., p. 133. Since the publication of the two indices by the author, the Academy has also published an "Index to the Literature of Electrolysis," *idem*, vol. ii., p. 313, by Mr. W. W. Webb.

The third portion of the author's preceding memoir was an essay upon "The History of Antozone and Peroxide of Hydrogen." It pointed out the fallacy of the arguments and proofs offered by Schönbein and Meissner, for the existence of the so-called antozone, and described the experiments of von Babo, Nasse, Engler, and others, by which the certainty of the non-existence of antozone has been demonstrated. The essay furthermore gave some account of the artificial sources of peroxide of hydrogen, and of the experiments devoted to a demonstration of its probable occurrence in nature. This was followed by a fourth part, devoted to an "Index to the Literature of Peroxide of Hydrogen" (1818-1878), similar in plan to that upon ozone.

In returning to this subject, it is with the hope of assisting fellow-students in two ways. First, by bringing these indices down to date, which will make the preceding work of much greater utility. Secondly, by pointing out the uselessness of repeating, as is being constantly done, the investigation of matters previously studied with thoroughness, and of overlooking other topics which are at present incompletely understood.

I. *Sources and Preparation of Ozone.*

The formation of ozone is to be looked for in all cases where the molecule of oxygen undergoes decomposition under conditions which render it possible for the constituent atoms to exist in a free or uncombined condition for an interval of time. This setting free of the constituent atoms of the molecule is what was known in the older chemistry as the nascent state of the element in question. And whilst the increased energy of chemical properties possessed by the element, at the instant of being liberated from a previous chemical combination, or in *statu nascenti*, was a fact of universally recognised importance, yet a satisfactory explanation of this increase of energy was not possible until the distinction between the chemical atom and the chemical molecule was established as a fundamental fact of the newer chemistry. Ordinarily, the nascent atom immediately enters into combination again, either with an atom of the same kind, as, for instance, an atom of hydrogen with an atom of hydrogen to form a moleeule of hydrogen in all respects similar in its properties to ordinary hydrogen gas, or with an atom of a different kind to form a different substance. In the case of oxygen, however, these free atoms may not only reunite by twos to form the ordinary dual molecule, known as oxygen gas, but by threes to form the triple molecule, which is ozone.

According to the older chemistry, it would have been difficult to assign a reason why free hydrogen atoms might not reunite to form a triple molecule of hydrogen, just as well as free oxygen atoms. And as a matter of history, Osann endeavoured to prove that the hydrogen given off in electrolysis differs from ordinary hydrogen, just as the oxygen given off differs from ordinary oxygen. He ascribed to such electrolytic hydrogen a weak acid smell, and the power of readily reducing silver and other metallic salts, and distinguished it by the name of ozone-hydrogen. But these properties were in reality due to other bodies in the electrolytic hydrogen, to say nothing of the fact that absolutely pure hydrogen gas has the power of slowly reducing silver from its salts.

It is not in accordance with our present knowledge concerning hydrogen, to regard the existence of such a body as Osann's supposed ozone-hydrogen as possible. For in all its known chemical combinations, hydrogen possesses but one bond of chemical attraction, and a molecule of hydrogen possessing three or more hydrogen atoms would lack the bonds to hold it together. Chlorine, on the other hand, has one, three, five, or seven bonds, according to the nature of the element with which it is brought into combination, and whilst it is certain that we do not understand the true meaning of this varying number of bonds, yet there is no reason why a number of allotropic modifications of chlorine might not exist, with different densities, colour, chemical properties, &c. So is it likewise with phosphorus, arsenic, nitrogen, and other polyvalent elements. The allotropism of phosphorus, for example, may be due to one of three causes: a difference in the amounts of internal energy, a difference in the relative positions of the constituent atoms, or a difference in the number of these atoms. The first supposition we need not entertain, because it would carry with it the admission that the differences between the substance-matter of all the elements themselves consists in differences in the quantity and kind of their internal energy. This admission chemists are not prepared to make. The last supposition includes the second, and explains the most important difference in the properties of the allotropic modifications of an element, their specific gravities. Moreover it is in harmony with the only case of allotropism, in which we are enabled to compare the allotropes in the gaseous condition, and it is in the gaseous condition that the relative number of atoms

in a molecule may be best compared. The specific gravity of ozone is to that of oxygen as 3 to 2, which is in harmony with the supposition, the most probable one on many other grounds as well, that the molecule of ozone consists of three, the molecule of oxygen of two atoms of oxygen.

The difference between the ordinary translucent modification of phosphorus and the red, may be explained by supposing the molecule of the former to contain 7 atoms, that of the latter 8. In this case the weights of the molecules would be as 217 to 248, or as 1·83 to 2·1, which latter numbers represent the actual specific gravities. Similarly, if we suppose the molecule of crystallised metallic phosphorus, the third allotropic modification, to consist of 9 atoms, its molecular weight in the solid condition would be to the molecular weight of ordinary phosphorus as 279 : 217 = 2·35 : 1·83, which latter numbers represent the actual specific gravities as determined by experiment.

Nitrogen was announced by Mr. Stillingfleet Johnson, in two papers read before the English Chemical Society in 1880, to be capable of existing in two allotropic modifications, his announcement being based on an experiment in which a certain kind of nitrogen, that obtained by the decomposition of ammonium nitrite, had been made to enter into direct union with hydrogen to form ammonia, while another kind of nitrogen, that existing in atmospheric air, would not so combine. But Mr. H. B. Baker has shown (Chemical News, xlviii., pp. 187, 279), that Mr. Johnson's results were erroneous, the mixed gases containing oxides of nitrogen, which gave rise to ammonia under the conditions of the experiment; and the existence of a new allotrope of of nitrogen is still under discussion.

To return from this consideration of allotropism in general, and examine the thesis at the beginning of the section:—The formation of ozone is to be looked for in all cases where the molecule of oxygen undergoes decomposition under conditions which render it possible for the constituent atoms to exist in a free or uncombined condition for an interval of time.

This setting free of the component atoms of the molecule (*status nascens*), always precedes the formation of ozone, inasmuch as before a combination of atoms by threes can occur, a decomposition of the preceding combinations by twos must take place. This, it will be urged, is a self-evident proposition, and I am very glad to admit that it is. But I am not the less impressed with the importance of distinctly formulating it in this place, because in much of the writing upon this topic it is ignored, and also because in many places this oxygen of the nascent state (free atoms), is called active oxygen and is frequently confused with ozone itself. This confusion is so probable (since ozone is most certainly the active allotrope of oxygen), that it appears to me inexpedient to speak of nascent oxygen as active oxygen, and of the process of making it as the activation of oxygen. To guard against this danger, I shall term the process the *atomation* of oxygen, and the freed atoms themselves, not active, but *atomic* oxygen. But, it may be asked, what experimental proof is there that atomic oxygen precedes in every instance the formation of ozone? The answer is to be found in the fact that ozone is incapable of producing certain chemical chanaes, readily producible by atomic oxygen; whilst, on the other hand, atomic oxygen, under the conditions referred to, can produce not only these chemical changes, but at the same time, and by a similar action, ozone itself.

The proof of this statement is set forth in a paper which the author published in the *Journal of the American Chemical Society* for 1879, p. 232, and subsequently in the *Proceedings* of the German Chemical Society.

It was there shown that carbon monoxide would undergo conversion into carbon dioxide, under the same circumstances as would bring about the conversion of ordinary oxygen into ozone; that is to say, when a mixture of carbon monoxide and air was subjected to the action of moist phosphorus. Later in the same year, I was induced by the theoretic importance of the subject, to study it anew, and to endeavour to learn whether the production of the carbon dioxide in this experiment was due to the action of ozone, or whether it was due to the production in the first place of atomic oxygen, and the subsequent combination of this atomic oxygen on the one hand with carbon monoxide to form carbon dioxide, and on the other hand with oxygen to form ozone.

Whether, in chemical language, the action was—

$$(1) O_3 + CO = CO_2 + O_2,$$

or, as a first step,

$$(2) O_2 = O + O,$$

and then, as second steps occurring simultaneously,

$$(3) O + CO = CO_2, \text{ and } O + O_2 = O_3.$$

In this second series of experiments (*Ibid.*, p. 450) I employed oxygen ozonised by the ozonising battery to the extent of 72 m.grms. of ozone per litre, while in the earlier experiments the percentage did not exceed 5 m.grms. per litre. But no production of carbon dioxide took place, however long the carbon monoxide and ozone remained in contact. Furthermore, when carbon monoxide and oxygen were separately submitted to the electric effluve, and then brought together, no carbon dioxide was formed. But when the two gases were first brought together in suitable proportion, and then the mixture submitted to the electric effluve, carbon dioxide was produced in quantities readily admitting of quantitative measurement.

I regarded this experiment as demonstrating the existence of atomic oxygen as prior to, and necessary to, the production of both carbon dioxide and ozone. In other words, that equations (2) and (3) represented the true sequence and co-ordination of the phenomena, and not equation (1).

Three years subsequently Baumann repeated this experiment (*Ber. der Deutsch. Chem. Gesell.*, xiv., 2706), and obtained the same result. These results having been questioned by Remsen and Keiser (*Amer. Chem. Journ.*, iv., 454) on the ground of their having obtained a negative result, I repeated my original experiment with air and carbon monoxide over moist phosphorus, every source of error being rigorously guarded against, and obtained even larger amounts of carbon dioxide than in my earlier investigation,—in one case 15·5 m.grms. Since that time Baumann has likewise repeated the experiment, and obtained in one trial, 23·3 m.grms. carbon dioxide, in another case 64·6 m.grms.

The atomation of oxygen, and the setting free of atomic oxygen, as a step necessarily antecedent to the formation of ozone, has therefore, I conclude, been established by rigorous experimental proof. In the case of the electric effluve, the intervening oxygen dielectric undergoes polarisation, and a certain number of its molecules are decomposed into atoms. Certain of these atoms re-combine among themselves, or combine with the oxygen molecules, to form ozone, the amount of the ozone produced depending upon the strength of the electric effluve, upon the duration of electrification, the temperature, presence of foreign gases or vapours admixed with the gaseous electrolyte, and the other conditions of the experiments.

If the atomation of the oxygen be brought about by the reduction of the oxygen molecule by means of phosphorus, partly covered by water, there will be formed by the atomic oxygen thus produced, ozone, hydrogen peroxide, and ammonium nitrate. If ammonium nitrite is produced, as an intermediary step, it is not found in the final products. These three substances, as I have always insisted since the publication of the investigation upon which the statement is based (*Journ. Amer. Chem. Soc.*, 1879, vol. i., 150), are three necessarily associated bodies, all secondary in their genesis, and dependent upon the previous formation of atomic oxygen. The reaction takes place, primarily, according to the equations—

$$(1)\ P_2 + 2O_2 = P_2O_3 + O \text{ and } P_2 + 3O_2 = P_2O_5 + O,$$

and secondarily, according to the equation—

$$O, O, O + O_2 + NN + 3H_2O = O_3 + H_2O_2 + NH_4NO_3^*$$

The ozone passes off in the atmosphere. The hydrogen peroxide and the ammonium nitrate mostly remain behind in the jar-water, though certain amounts can be detected in the wash-waters, if any such be employed to wash the escaping ozone. The white cloud above the wet phosphorus is mainly hydrogen peroxide associated in a state of vesicular suspension with aqueous vapour, and constitutes the antozone cloud of Schönbein (the atmizone of Meissner).

In all these cases, besides the production of atomic oxygen as a necessary antecedent, its formation at temperatures consistent with the possible formation of ozone, hydrogen peroxide, &c., must be predicated. And inasmuch as ozone is slowly converted even at the boiling point of water into oxygen (at once at a temperature of 237° C.), the importance of maintaining a low temperature is manifest. When the atomation of oxygen is brought about by moist phosphorus, no action occurs below 6° C. At 24° the formation of ozone is at a maximum, the production falling off very rapidly, as the temperature rises above this point. When atomic oxygen is set free in the electrolysis of acidulated water, the gas evolved at the positive electrode contains, according to Soret, 1 p. c. of ozone, when the temperature of the electrolyte is maintained at 6° C., and 2 p. c. when at 0°.

But whilst the lower temperatures spoken of are those most favourable to the permanence of the products of the action of atomic oxygen, yet the evidence is very strong that even under circumstances apparently unfavourable and at high temperatures, the atomic oxygen may bring about the formation of ozone, hydrogen peroxide, and ammonium nitrite. It was stated by Loew (Chemical News, xxi., p. 107), that ozone is formed when air is blown through a gas-flame under proper conditions. This was denied by Böttger (*Chem. Centr.*, 1870, 161), who stated that ammonium carbonate and hydrogen peroxide are formed under these conditions. During the same year (1870), Than brought forward certain experiments to show that ozone was formed during the rapid combustion of all hydrogenous bodies. (*J. pr. Chem.* [2], i., 415.) The year following Pincus confirmed Than's statement (*Pogg., Ann.*, cxliv., 480), and Struve published his research to show that ozone, hydrogen peroxide, and ammonium nitrite, all three were formed in the combustion of hydrogen (*Bull. de l'Acad. Imp. des Sci. de St. Petersbourg*, xv., No. 3). By experiments conducted with extreme care, Zoeller and Grete (*Berl. Berichte*, x., 2144), showed that in the burning of pure hydrogen in pure air, ammonium nitrite is formed in very notable quantities. Much later Böttger (*Chem. Centr.*, 1878, p. 574) found that hydrogen peroxide is formed on the explosion of a mixture of pure oxygen and hydrogen. Inasmuch, however, as certain very careful observers, like Zoeller and Grete, have demonstrated the formation of one only of the three products, it is necessary that a more complete demonstration of the production of all three bodies in rapid combustion be brought forward, before it can be regarded as finally established.

The subject of the atomation of oxygen was studied at great length by Schönbein, and a large number of important facts noted by him. But at that time the true nature of ozone was not known. According to Schönbein, ozone itself was one kind of atomic oxygen, namely, the free atom in an electro-positive condition, and antozone another kind of atomic oxygen, the free atom in an electro-negative condition. He supposed that it was the latter kind which, in contact with water, generated hydrogen peroxide. Although ozone is certainly not what Schönbein supposed it to be, yet the existence of atomic oxygen, as something necessarily preceding the formation of ozone, may now be regarded as a demonstrated fact. And whilst it has not been shown that the free oxygen atoms may exist in two electro-negative conditions, yet such an hypothesis is theoretically not untenable, nor has it been demonstrated to be false.

Latterly, the number of cases in which the formation of active oxygen has been noted has been largely increased. Thus Hoppe-Seyler has pointed out that is formed when palladium-hydrogen is shaken up in contact with water and air (*Berl. Berichte*, xii., 1551). Under these circumstances he noted the formation of the third by-product, ammonium nitrite, as well. The author, prompted by theoretical considerations, sought for the presence of ozone and hydrogen peroxide, since according to the hypothesis above enunciated, both should be present. Ozone he failed to detect, hydrogen peroxide was found in quantity large enough to admit of its quantitative estimation (*Berl. Berichte*, xiv., 970). So also palladium, platinum, and other so-called "carriers of oxygen," owe the energetic oxidising actions which occur in their presence, and which were formerly spoken of as "catalytic," to their power of affecting a separation of the oxygen molecule into its constituent atoms. This is shown by the experiments of Traube and Baumann, who found that palladium will cause the oxidation of carbon monoxide to dioxide in presence of hydrogen peroxide, whilst without palladium no such oxidation occurs. It has been likewise noted by the author that platinum black, when shaken up in a bottle partly filled with air, along with a solution of indigo, turns the latter yellow by causing its oxidation and the formation of isatin. Since this very powerful oxidising action is not produced by oxygen in its ordinary condition, it may be ascribed to the atomation of the oxygen under the influence of the platinum black.

The number of observed cases of the formation of atomic oxygen has been largely increased by the recent researches of Radziszewski on the phosphorescence of Organic Bodies. He divides such phosphorescent organic bodies into two groups: 1st. Those which phosphoresce when the atomic oxygen which they already contain, and which has been previously formed under the influence of some activating agent like sunlight, operates upon the organic body, on the addition of an alkali. 2nd. Those bodies which, on the addition of an alkali, themselves form atomic oxygen, and by combining with this atomic oxygen, become phosphorescent. To the first group belong various hydrocarbons, especially the aromatic, the terpenes, &c. To the second, belong more especially the aldehyds, or such bodies as when treated with an alkali form aldehyds. To the latter sub-division belong the fats of the series $C_nH_{2n-2}O_2$. Radziszewski explains in like manner the phosphorescence of organisms, since he finds in them a fat, together with an alkaline body. And in one of these, the *Pelagia noctiluca*, he thinks he has demonstrated the presence of atomic oxygen, by showing that the *Pelagia* develops a blue colour when placed on porous plates moistened with potassium iodide, starch paste, and tincture of guaiacum.

II. *Nature and Properties of Ozone and Hydrogen Peroxide.*

The recent remarkable discoveries concerning the properties of ozone have strengthened the grounds on which the hypothesis of the nature of ozone stands. Recently, a lengthy series of memoirs has been written by Traube, in which he controverts both the present theory, as to the constitution of hydrogen peroxide, and the views now entertained of its action as an oxidising agent. Hitherto, chemists have looked upon hydrogen peroxide es oxidised water, from the fact that it yields up one of its atoms of oxygen with great readiness, and therefore acts as an energetic oxidising agent. In order that water may take up another atom of oxygen, a molecule of oxygen or an

* In an article upon the "Preparation of Phosphoric Acid by the oxidation of Phosphorus with Air in Presence of Moisture" (*Pharm. J. Trans.* [3], xiv., 24-26, and *Journ. Chem. Soc.*, December, 1883, p. 1050), W. T. Wenzell has obtained the same results, and has adopted in their explanation the hypothesis here stated.

oxide must be decomposed, or an atom of atomic oxygen must enter into direct combination. Thus—

$$H—O—H + O = H--O--O—H.$$

Traube, on the other hand, has brought forward a number of experiments to show that peroxide of hydrogen is reduced oxygen; that is to say, the oxygen in the peroxide enters as a whole molecule, and as a molecule exists in combination with two atoms of hydrogen. But whilst Traube states the above as his hypothesis, and that both the atoms of oxygen are combined in the same manner, and with the same degree of chemical attraction, yet the structural formula which he gives is the same as the one ordinarily adopted; nor is the fact that one only of the oxygen atoms is readily parted with, explained by his theory any more satisfactorily than by the ordinary one. Moreover, the experiments, as detailed by Traube, are in opposition to the results many times obtained by the author in their repetition.

Without detailing these results in this place, it will suffice to state that when zinc in fine division is shaken up with water and air, the oxygen of the air causes an energetic oxidation of the zinc. As a result of this oxidation, the oxygen molecule is divided, one atom going to the zinc and the other being for an instant set free. This atomic oxygen brings forth very energetic oxidations, oxidising indigo to isatin, forming hydrogen peroxide, decomposing potassium iodide, and developing nitrous acid. The latter speedily disappears, being oxidised by the peroxide of hydrogen to nitric acid, while the excess of peroxide of hydrogen, which appears to be the most abundant product of the reaction, is decomposed by the zinc.

It might be supposed that these phenomena are due to the oxidation of nascent hydrogen set free by the decomposition of the water itself, But this is not the case. Pure zinc does not decompose water, and ordinary zinc decomposes it in too small an amount to explain the observed phenomena. This being the case, zinc acts in a manner analogous to phosphorus, viz.:

$$Zn+H_2O+O_2=ZnH_2O_2+O$$

An experiment recently performed by Kappel can be best explained in like manner. On agitating Cu with an alkaline solution and air, he obtained the reaction both for ozone and hydrogen peroxide, but not the nitrous reaction. His test-papers suspended above the liquid became blue, but were immediately decolourised, a result attributed to the decomposition of the ozone first formed, by the peroxide of hydrogen. For on passing a current of air so as to remove the ozone, the hydrogen peroxide reaction was readily obtained. (*Berl. Berichte*, xv,, 2359.)

III. *Liquefaction and Colour of Ozone.*

The most important discoveries during the past three years concerning the properties of ozone, are those made by Hautefeuille and Chappuis. They found that ozone is a blue gas, the colour appearing sky-blue even when only so much ozone is present as is obtained in the ozonation of the oxygen contained in a tube a metre in length by the silent discharge. Furthermore, they found that under very great pressures the condensed gas becomes indigo blue. If the pressure is increased to 75 atmospheres and then suddenly relieved, a dense white cloud is formed, showing the beginning of liquefaction, whilst the same phenomenon does not take place with pure oxygen until a pressure of 300 atmospheres is attained. The ozone must be compressed slowly and with constant cooling, otherwise it will explode with evolution of heat and light. By mixing the ozone with carbon dioxide, and then submitting the mixture to great cold and pressure, Hautefeuille and Chappuis succeeded in obtaining a deep blue liquid, the blue colour being due to the liquefied ozone.

The same observers have studied the absorption-spectrum of ozone, and accurate measurements of the same have been made by W. N. Hartley. The latter has extended the research to the absorption of certain parts of the sun's rays by atmospheric ozone. By this new optical method he has arrived at the conclusions—1st. That ozone is a constant constituent of the upper atmosphere. 2nd. That it is present in larger amounts in the upper than in the lower part of the earth's atmosphere. 3rd. That it is the cause of the blue colour of the sky.

IV. *Atmospheric Ozone.*

In a former paper published in the *Annals* of the Academy, "Upon Ozone and the Atmosphere," I have detailed at length the experiments by which I sought to show that the so-called ozonoscopes, such as Schönbein's potassium iodide starch-papers, and Houzeau's potassium iodide and litmus papers, were of no value as tests for ozone *per se*, since they were equally affected by hydrogen peroxide, which is also present in the air. Schöne has arrived at the same results. But he has also shown that whilst even thallium papers are of no value as ozonoscopes, they are of value in the determination of atmospheric hydrogen peroxide by exact chemical methods. Thus at the very time when the estimation of atmospheric ozone by any known chemical method had been found impossible, the researches of Hautefeuille, Chappuis, and Hartley pointed out an entirely unlooked-for means of overcoming the difficulty. But as yet the practical utilisation of their discovery, and the influence of moisture, hydrogen peroxide, and other constituents of the atmosphere, in confusing or rendering difficult the observation of the ozone absorption-spectrum, have not yet been made known.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XIII.

Communicated by F. P. DUNNINGTON.
Acting Professor of General and Analytical Chemistry.

(Concluded from p. 210).

(114). *Estimation of Sulphur Dioxide.* By C. L. Reese.

The process proposed is as follows:—

A standard solution of potassium permanganate is employed to ascertain the strength of a solution of hydrogen dioxide according to the reaction.

$$2KMnO_4+3H_2SO_4+5H_2O_2= =K_2SO_4+2MnSO_4+8H_2O+5O_2.$$

Now put the portion of the sulphur dioxide solution to be determined into a glass stoppered bottle; to this add a few drops of a solution of titanium sulphate, and then titrate with the solution of hydrogen peroxide until the yellow colour produced by the action of the latter on titanic oxide is permanent on shaking. The colour may appear before all the sulphur dioxide is oxidised, but it will then disappear on shaking. The odour of the sulphur dioxide well enables one to judge of the amount of hydrogen peroxide needed in the titration, since a very small amount of it can be thus detected after shaking.

The following experiments were made:—

A portion of a solution of sulphurous acid, obtained by bubbling the gas through water, was treated with excess of hydrogen peroxide, boiled, acidified, and then treated with excess of barium chloride; the amount of barium sulphate obtained corresponded to sulphur dioxide originally present, 1·096 grm. A similar portion estimated by the above method gave sulphur dioxide, 1·104 grm., being 100·7 per cent of the former. A sealed glass tube containing pure liquefied, sulphur dioxide was weighed, and the whole of the contents dissolved in a three litre flask of water; the tube finally weighed gave the total

weight of sulphur dioxide employed; we will call this 100. A measured portion of this was oxidised by excess of hydrogen peroxide and the sulphur trioxide weighed as barium sulphate. Two other portions were titrated by hydrogen peroxide according to the above method, giving the following estimates of the sulphur dioxide:—

By weight of liquefied gas	100
,, ,, barium sulphate ..	99·7
,, 1st titration	96·6
,, 2nd ,, ...	97

The errors in the process are undoubtedly mainly due to the loss of sulphur dioxide which occurs on exposure of the solution to the air.

In view of the very unsatisfactory character of the estimation of sulphur dioxide by direct oxidation by potassium permanganate, the above method of making this estimation, suggested by Mr. W. G. Brown, although not very accurate, will prove of some value as a volumetric method.

(115). *Comparative Oxidation of Solutions of Sulphurous Acid and of Sodium Sulphite.* By C. L. Reese.

While it is well known that solutions of the sulphites are oxidised on exposure to the air, I believe it is generally thought that these solutions are more permanent than are those of sulphurous acid solutions under similar conditions. On more than one occasion I have been annoyed to find that a reagent bottle in which there had been put a solution of sodium sulphite contained only the sulphate. I therefore proposed to Mr. Reese to examine the relative rates of oxidation of these solutions. Owing to a misunderstanding, the strength of the several solutions were not such as I preferred, but this was noted when it was too late to correct it.

The sodium sulphite employed was that of E. Merck; it contained about one-fifth of sulphate, and I therefore state the strength of the solution in terms of the sulphur dioxide present. Three solutions of the sulphite, 1, 3, and 5, and two solutions of sulphurous acid, 2 and 4, were put into half-gallon green glass acid bottles, nearly filling them. The neck of each of these was closed up by a cork, through which passed a short open tube 2 m.m. in diameter bent outside the bottle to keep out dust. These stood side by side in daylight in the balance room, and each week portions were removed for analysis. No record was kept of the temperature, which varied often between 50° and 90°, the experiment extending from March 19th to June 12th. The method of estimation of the sulphur dioxide employed was that described in the previous article. The gradual diminution of the SO_2 and its oxidation is expressed in the following:—

Table I.—*Parts of* SO_2 *in* 1000 *Parts of Water.*

	1.	2.	3.	4.	5.
Beginning	21·10	6·00	3·77	1·063	0·765
After 1 week ..	20·60	5·94	2·45	0·971	0·183
,, 2 weeks ..	18·30	5·29	1·28	0·737	0·028
,, 3 ,, ..	17·16	4·97	0·64	0·664	0·006
,, 4 ,, ..	16·42	4·62*	0·29	0·577	—
,, 5 ,, ..	15·53	4·61	0·18	0·461	—
,, 6 ,, ..	14·21	4·29	0·11	0·362	—
,, 7 ,, ..	13·03	3·73	0·00	0·240	—
,, 8 ,, ..	11·93	3·52	—	0·162	—
,, 9 ,, ..	11·05	3·16	—	0·100	—
,, 10 ,, ..	9·21	2·95	—	0·072	—
,, 11 ,, ..	8·70	2·77	—	0·055	—
,, 12 ,, ..	7·34	2·55	—	0·031	—
After 12 wks. total amount oxidised	13·76	1·85	3·77	1·055	0·765

We may throw the result in another form, in each case designating the amount of sulphur dioxide originally present as 100. We have the following:—

Table II.

	1.	2.	3.	4.	5.
Beginning	100	100	100	100	100
After 1 week	98·1	99·1	65·1	91·3	23·8
,, 2 weeks	86·7	88·2	35·4	69·3	2·3
,, 3 ,, ...	81·4	82·9	17·0	62·3	0·7
,, 4 ,, ...	77·8	76·9*	7·8	54·3	0·0
,, 5 ,, ...	72·6	76·8	4·8	43·4	0·0
,, 6 ,, ...	67·3	71·6	2·7	34·0	0·0
,, 7 ,, ...	61·7	62·1	0·0	22·6	0·0
,, 8 ,, ...	56·5	58·6	0·0	15·1	0·0
,, 9 ,, ...	52·4	52·7	0·0	9·4	0·0
,, 10 ,, ...	43 6	49 2	0·0	6·5	0·0
,, 11 ,, ...	41·2	46·1	0·0	5·1	0·0
,, 12 ,, ...	34·1	42·5	0·0	2·9	0·0
After 12 wks. oxidised	65·9	30·8	100 0	98·3	100·0

From the above we may draw the following conclusions:—

First. That with each of these substances the weaker solutions oxidise more rapidly.

Second. That with weak solutions the sulphite is more rapidly oxidised than sulphurous acid.

Third. That although solution 2 was not so much oxidised as solution 1, yet it lost its strength almost as rapidly by reason of the escape of sulphur dioxide, and we might expect a stronger solution to part with any additional strength yet more rapidly.

Fourth. That the sulphite solution, so long as any sulphite remained, took up oxygen at about a constant rate independently of the strength of the solution, this rate being probably determined by the extent of the exposure to air.

(116.) *Analysis of Infusorial Earth, Richmond, Va.* By J. M. Cabell.

Since the analyses heretofore made of this well-known infusorial earth appear to have been of rather impure specimens, Mr. Cabell procured from the middle of the exposed bed of this earth just below the coloured normal school on President's Hill, in Richmond, Va., a speciman which, without any previous treatment, proved to be almost exclusively composed of distinguishable infusoria.

It is white with tinge of yellow, feels a little harsh; sp. gr. of mass coated with varnish = 0·922, the sp. gr. of powder = 2·321.

Analysis afforded the following:—

Silica dissolved in 1st hour	29·60	
,, 2nd ,,	4·79	75·68
,, undissolved	41·29	
Alumina		9·88
Ferric oxide		2·92
Lime		0·29
Magnesia		0·69
Potash		0·02
Soda		0·08
Nitrogenous matter (nitrogen × 6) ..		0·84
Water by H_2SO_4	3·37	
,, by 100° C.	1·17	8·37
(less N) by ignition	3·83	
		98·77

To ascertain the solubility of the silica as above, the powder was boiled in a 20 per cent solution of sodium hydrate.

(117.) *Analysis of a Variety of Chloropal from Albemarle Co., Va.* By L. N. Chappell, of Forestville, N. C.

This mineral is found, in leaf-like pieces, in sizes from fine grains up to 8 c.m. in diameter and 1 c.m. thick, in a mass of disintegrating rock which could not be recognised, the remainder of which formed a ferruginous clay. This

* The irregularities of the apparent alteration of the sulphur dioxide solution may in part be due to the irregularities of the temperature.

decomposing rock appears to follow a vein of limonite and quartz; the larger pieces of the green mineral lying nearest to the limonite. The country rock is largely composed of quartz, felspar, and epidote, with occasionally almandine. The mineral in question is massive, quite soft when first dug up, but on drying becomes harder and brittle with earthy fracture, cuts under the knife, giving a faintly greasy lustrous surface, is greasy to touch, not adhering to the tongue, of light yellowish green colour. Hardness about 1 sp. gr. = 2·06. Fuses to a black glass at about 3. Is decomposed with separation of silica by hydrochloric or sulphuric acid.

Analysis afforded the following:—

		Oxygen ratio.
Silica	38·64	128
Alumina	20·05	60
Ferric oxide	22·18	30
Ferrous oxide	0·04	
Lime	1·09	
Magnesia	0·44	
Water	15·71	120
	98·15	

giving the formula—

$$2(\tfrac{3}{4}H_2O,\tfrac{1}{4}Fe_2O_3,\tfrac{3}{4}Al_2O_3),3SiO_2+4\tfrac{1}{2}H_2O,$$

which nearly corresponds to that of pinguite, a variety of chloropal, $2Al_2O_3,3SiO_2+4\tfrac{1}{2}H_2O$.

(118.) *Analysis of Kaslinite from Calhoun Co., Ala.* By G. H. ROWAN.

An unusually pure specimen of clay from a deposit about 12 miles S. W. from Jacksonville presents the following properties.

White, with a tinge of cream colour, earthy, with clayey odour, adheres to tongue, feels slightly greasy; sp. gr. of powder = 2·509, sp. gr. of specimen coated with varnish = 1·688.

Analysis afforded the following:—

		Oxygen ratio.
SiO_2	45·77	197
Al_2O_3	89·45	150
CaO	0·79	
H_2O	13·96	100
MgO,Fe_2O_3	trace	
	99·97	

Showing a very close agreement with the theoretical composition of kaolinite, $2SiO_2,Al_2O_3,2H_2O$.

After this analysis was completed it was found that an examination of this clay was made in 1855 by Dr. J. W. Mallet.

[See Second Biennial Report of the Geological Survey of Alabama, by M. Tuomey, 1858.]

(119.) *Analysis of Marmalite from Himmelfahrt Mine, Freiberg.* By JAMES DOUGLAS BRUCE.

This specimen was received of Dr. O. Krantz among some minerals for analysis, and presented the usual appearance of marmalite. An analysis afforded the following composition:—

Zinc	50·82
Iron	14·52
Copper	2·35
Antimony	1·14
Manganese	trace
Sulphur	31·67
Insol. residue	0·14
	100·64

Agreeing with the formula 3ZnS.FeS.

The unusually large amount of antimony and of copper present occasions this note of it.

(120.) *Analysis of Garnet (var. Spessartite), from Amelia Co., Va.* By C. M. BRADBURY, of Petersburg, Va.

This mineral is from the mica mine aboved referred to.

It is of a pale pink to flesh-red colour, resembling rhodonite more than the usual form of garnet. Hardness = 6·5; sp. gr. = 4·20.

Analysis afforded the following:—

Silica	36·34
Alumina	12·63
Ferrous oxide	4·57
Manganous oxide	44·20
Lime	1·49
Magnesia	0·47
Water	trace
	99·7

It will be noted that the manganese is unusually high, and the iron and alumina unusually low.

University of Virginia,
August 22, 1884.

ON THE

ACTION OF PHOSPHORUS TRICHLORIDE ON ANILINE.

By C. LORING JACKSON and A. E. MENKE.

THE only paper on this subject which we have been able to find was published by Tait in 1865.* In it he describes the product of the action of phosphorus trichloride on aniline as a white salve-like mass easily soluble in water, alcohol, and ether, which, when freed from an excess of aniline, had the composition $(C_6H_5NH)_3P3HCl$, gave a chlorplatinate and several double salts, but yielded no satisfactory result when he attempted to set free the base.

We were induced to take up the study of this reaction by the hope that a further investigation of Tait's substance might lead to interesting results; but in this we were disappointed, as we have not succeeded in obtaining it, and, as far as our experiments go, are inclined to think it must have been a mixture instead of a definite compound. At the same time we cannot state with absolute certainty that it is not present in the product formed when a decided excess of aniline is used, since the impossibility of continuing our work after the beginning of the summer vacation prevented us from making the investigation of this product as thorough as we wished. For the same reason other parts of this research can be published only in a very fragmentary and imperfect condition.

The isolation of the compounds containing phosphorus formed by the action of phosphorus trichloride on aniline, in the proportion of one molecule to three, is surrounded by difficulties which we have found insurmountable; but, in spite of this, our experiments have determined with a fair degree of certainty the nature of these compounds, as will appear from the following general statement of our results, and the argument which can be based upon them.

When aniline is added to phosphorus trichloride in the proportion of three molecules of the former to one of the latter, the product, a variable mixture of aniline chloride and a substance containing phosphorus, gives a clear solution with water or alcohol. If, however, this product is heated, a waxy mass is obtained, which is soluble in alcohol; but water throws down from this solution a white precipitate having the formula $(C_6H_5NH)_2PHO$. Of the three most probable products of the reaction of phosphorus trichloride and aniline,—

(1) $C_6H_5NHPCl_2$,
(2) $(C_6H_5NH)_2PCl$,
(3) $(C_6H_5NH)_3P$,

* *Jahresbericht der Chem.*, 1865, 411. *Instit.*, 1865, 254.

only (2) could yield $(C_6H_5NH)_2PHO$ by the action of water or alcohol, and we therefore infer that—

$$(C_6H_5NH)_2PCl$$

exists in the product after it has been heated. On the other hand, this substance cannot exist in the original product, as this dissolves in water without residue, whereas $(C_6H_5NH)_2PCl$ is converted by water into the insoluble $(C_6H_5NH)_2PHO$; but it must be formed from one of the constituents of the crude substance during the heating. Of the two probable products of the reaction, (1) and (3), mentioned above, it is hard to see how—

$$(3)\ (C_6H_5NH)_3P,$$

by heating with aniline chloride, could be converted into $(C_6H_5NH)_2PCl$, while—

$$(1)\ C_6H_5NHPCl_2$$

could easily undergo this change under these conditions; from which we conclude that $C_6H_5NHPCl_2$ and aniline chloride are the products of the action of aniline on phosphorus trichloride under the conditions mentioned. This conclusion is supported by the fact that alcohol or water acts violently on the original product forming aniline phosphite, and it is highly improbable that $(C_6H_5NH)_3P$ would give such a violent reaction.

The remainder of this paper contains a detailed account of the experiments on which the above conclusions are based, a description of the properties and behaviour of the new substance $(C_6H_5NH)_2PHO$, and a somewhat fragmentary account of two crystalline substances formed by boiling the crude product with an excess of aniline, one of which may be a derivative of $(C_6H_5NH)_3P$, although this point needs confirmation by further experiments.

Action of Phosphorus Trichloride on Aniline.

When aniline is added to phosphorus trichloride the reaction is attended with so much heat that each drop of the aniline hisses like red-hot iron in water when it touches the trichloride; and, if the substances are mixed in about the propertion of three molecules of aniline to one of the trichloride, the product is a hard white solid, with no trace of the salve-like consistency described by Tait. It was proved to be a mixture by the following analyses of three different preparations, which were freed from an excess of either reagent by washing with ether before analysis.

	I.	II.	III.
Carbon	50·82	54·41	43·59
Hydrogen	6·28	7·07	7·10
Chlorine	19·38	23·15	—
Phosphorus ..	5·48	2·92	—

In the hope of isolating the phosphorus compound, the action of various solvents on the mass was studied,—of all the common solvents, water, alcohol, methyl alcohol, and acetone were the only ones in which it was not essentially insoluble; but, as we found that acetone dissolves aniline chloride, there was no prospect of achieving the purification of the phosphorus compound by its means, and either water or alcohol decomposed it, giving a clear solution,* which, on evaporation, left a viscous residue, apparently composed of chloride and phosphite of aniline, as it deposited crystals of the former after standing for some time, and upon solution in water and addition of plumbic acetate gave a heavy white precipitate, which, freed from plumbic chloride by washing with hot water, was proved to be plumbic phosphite, by the following analysis:—

0·6986 grm. of the salt gave 0·7380 grm. of plumbic sulphate.

	Calculated for $PbHPO_3$.	Found.
Lead	72·13	72·16

From this result it is probable that no anilido-phosphorus acid was formed.

* When water was used there was sometimes a slight residue of $(C_6H_5NH)_2PHO$.

From what has been said it appears that the product described above differs from Tait's in consistency, in its solubility in ether, and in composition; but if, instead of fulfilling the conditions given above, the trichloride is added to a large excess of aniline, a substance is obtained which resembles Tait's in its salve-like consistency and the fact that it gives a considerable extract with ether; at the same time we cannot think that it has the composition ascribed to it by him, because our analyses given above show that the substance must contain aniline chloride, and this would not have been removed by mere solution in water, the only purification to which it was submitted by Tait. We may add that the solid matter apparently extracted by ether was really dissolved in the excess of aniline, as it proved insoluble in ether after the aniline was removed, and, as aniline dissolves aniline chloride, we saw no prospect of purifying the phosphorus compound in this way. If, on the other hand, an excess of phosphorus trichloride was used, the product was a white compact mass, from which a considerable amount of solid matter was extracted with ether; but this was due evidently to its solubility in phosphorus trichloride rather than in ether, and, as it contained only 2 per cent of phosphorus, it was not thought worth while to pursue this part of the subject further.

Action of Heat on the Original Product.

If the mixture, analyses of which were given above, is heated, it turns orange-red, and gives off aniline chloride, the purity of which was determined by analysis, and a small quantity of a phosphorescent gas, probably phosphoretted hydrogen. This change takes place slowly and partially even at 100°, much more rapidly and completely at 150°, or at even higher temperatures. We usually heated the mass in a porcelain dish over a free flame, regulating the temperature so that aniline chloride sublimed off freely, but no spontaneously inflammable phosphoretted hydrogen was given off. The product when heated with alcohol gave a colourless solution, and a residue of an orange or red colour, according to the length of time it had been heated. As this residue was insoluble in all solvents, and could not be purified completely by washing, we are in doubt as to its precise nature; but, as one preparation contained as much as 81·73 per cent of phosphorus, it cannot be an organic compound, but is either amorphous phosphorus, or the red oxide or solid hydride of that element. The alcoholic solution when treated with water gave a white precipitate of—

$$(C_6H_5NH)_2PHO,$$

while anilide chloride and phosphite were left in solution, with, so far as we could find, no other substances. The formation of the red body is not essential to the production of the mother-substance of $(C_6H_5NH)_2PHO$, as we obtained, by short heating in a dry test-tube, a yellowish waxy mass, which dissolved completely in alcohol, and yielded a large amount of $(C_6H_5NH)_2PHO$ on addition of water; upon longer heating, however, the yellowish substance turned orange-red.

Before going to the description of the phosphorus anilid $(C_6H_5NH)_2PHO$, we may add, that we tried to obtain the chlorine compound from which it is formed by treating the freshly heated orange mass with benzol or with absolute ether, as these solvents seemed to offer the best chance of success. The amount extracted in either case was extremely small, and possessed the most unpromising properties, the ether extract containing lumps of ordinary phosphorus imbedded in a viscous mass, while the benzol extract resembled semi-liquid paint, and gave no evidence that it was a homogeneous compound; it was analysed, however, and contained 5·12 per cent of chlorine and 21·27 per cent of phosphorus, whereas $(C_6H_5NH)_2PCl$ requires 14·17 per cent of chloride and 12·37 of phosphorus.

Phosphorus Anilid, $(C_6H_5NH)_2PHO$.

The preparation of this substance has been just described. In order to purify it, as it did not crystallise, the crude

precipitate was re-dissolved in a little alcohol, and precipitated with water; the viscous mass thus obtained was kneaded thoroughly with water, dissolved again in alcohol, and once more precipitated and washed with water; it was then dried at about 50°, and its composition determined by the following analyses of a number of different preparations.

I. 0·3488 grm. of substance gave 0·7992 grm. of carbonic dioxide and 0·1918 grm. of water.

II. 0·2856 grm. gave 0·6502 grm. of carbonic dioxide and 0·1610 grm. of water.

III. 0·2190 grm. gave 0·5012 grm. of carbonic dioxide and 0·1180 grm. of water.*

IV. 0·3402 grm. gave after treatment, according to Carius, 0·1590 grm. of magnesic pyrophosphate.

V. 0·2016 grm. gave 0·0976 grm. of magnesic pyrophosphate.

VI. 0·4623 grm. gave 49·9 c.c. of nitrogen at a temperature of 25° and pressure 766 m.m.

	Calculated for $(C_6H_5NH)_2PHO$.	Found. I.	II.	III.	IV.	V.	VI.
Carbon	62·07	62·47	62·04	62·41	—	—	—
Hydrogen	5·60	6·10	6·26	5·99	—	—	—
Phosphorus	13·36	—	—	—	13·05	13·52	—
Nitrogen	12·07	—	—	—	—	—	12·13

Properties.—It forms a white amorphous mass which melts at 87°; all our attempts to obtain it in crystals have been unsuccessful; it is freely soluble in cold alcohol and in ether, insoluble in cold water, but melts under boiling water, and perhaps dissolves to a very slight extent. It is a perfectly neutral body, neither acids nor alkalies affecting it in the cold; even alcoholic sodic hydrate or sodic ethylate acts on it with difficulty; on the other hand, fuming hydrochloric acid, when boiled with it for twelve hours, decomposes it completely into aniline chloride, phosphoric acid, and a small quantity of carbonaceous substance. The formation of the aniline chloride was proved by an analysis of the sublimate, 0·2776 grm. giving 0·3114 grm. of argentic chloride,

	Calculated for $C_6H_5NH_3Cl$.	Found.
Chlorine	27·41	27·74

the formation of phosphoric acid by qualitative tests with argentic nitrate and ammonic molybdate.

Action of Nitric Acid.—When the substance is gently heated with fuming nitric acid it forms a red solution, from which water precipitates a red resinous body which contains phosphorus, but was not studied further, as the quantity was not large, and its properties were uninviting. By far the principal products of the reaction were contained in the aqueous solution, which left on evaporation yellow crystals having acid properties, and easily characterised by their appearance and melting-point, 120°, as picric acid. Another preparation yielded instead of picric acid the unsymmetrical meta-dinitro-phenol, melting at 113°—115°. These results can be explained by supposing that the nitric acid saponifies the anilid, forming aniline nitrate and phosphoric acid, and the former is afterwards converted into the nitro-phenols by the combined action of nitrous and nitric acids.

Action of Acetic Anhydride.—If phosphorus anilid is heated with acetic anhydride and fused sodic acetate on the water-bath, and the product extracted with ether, a viscous mass is obtained, which gradually becomes partially converted into crystals free from phosphorus, melting at 112° after re-crystallisation from water, and therefore acetanilid.

From all the observations described above it appears that the substance behaves like an anilid of phosphorus acid.

Action of an Excess of Aniline on the Original Product.

If the immediate product of the action of phosphorus trichloride and aniline, or this product after it has been heated, is boiled for some time with an excess of aniline, there results a mixture of various substances from which we have succeeded in isolating the orange-red substance and phosphorus anilid already described, chloride and phosphite of aniline, and a crystalline substance melting at 208°. There seems to be also a substance with a higher melting-point, and on one occasion a body melting at 150° was obtained; unfortunately we were obliged to break off work on this part of the subject before we had done more than analyse the two substances melting at 208° and 150° respectively, so that we have as yet no satisfactory data for determining their constitution, and also have been able to make no exhaustive search for other products.

Substance melting at 208°.—This compound is obtained from the mixed products of the reaction by washing out the soluble salts with water, extracting the residue with hot alcohol, and purifying the extract by crystallisation from alcohol, till it shows a constant melting-point. It was dried at 100° and analysed.

I. 0·3352 grm. gave 0·8032 grm. of carbonic dioxide and 0·1770 grm. of water.

II. 0·2946 grm. gave 0·7047 grm. of carbonic dioxide and 0·1520 grm. of water.

III. 0·2528 grm. gave 0·1200 grm. of magnesic pyrophosphate.

IV. 0·2492 grm. gave 0·1200 grm. of magnesic pyrophosphate.

V. 0·3424 grm. gave 40·44 c.c. of nitrogen at a temperature of 20·5° and a pressure of 757·3 m.m.

	I.	II.	III.	IV.	V.	Mean.
Carbon ..	65·34	65·24	—	—	—	65·29
Hydrogen..	5·86	5·73	—	—	—	5·79
Phosphorus	—	—	13·25	13·47	—	13·36
Nitrogen ..	—	—	—	—	13·38	13·38

These results agree most nearly with the formula $(C_6H_5NH)_8P_4OH_2$, but are not far removed from $(C_6H_5NH)_7P_3O_2H_2$, as is shown by the following comparison:—

	Calulated for $(C_6H_6N)_8P_4OH_2$.	Mean of Analytical results.	Calulated for $(C_6H_6N)_7P_3O_2H_2$.
Carbon ..	65·61	65·29	65·37
Hydrogen ..	5·71	5·79	5·70
Phos... ..	14·12	13·36	12·06
Nitrogen ..	12·75	13·38	12·71

Acccording to the first of these formulæ the substance would be a derivative of the red oxide or hydrate of phosphorus, while the second can be developed into—

$$[(C_6H_5NH)_3P]_2H_2O_2PC_6H_5NH;$$

it is possible, therefore, that a study of the decomposition products of the substance might throw light on its composition. With this view we heated some of it to 140° in a sealed tube with hydrochloric acid and obtained phosphorus and phosphoric acids, aniline chloride, some carbon, and an odour of phenol, but no red product; we have also found that boiling aniline with the red substance, so often mentioned, does not give this compound melting at 208°, so that our results are in favour of the second for-

* We found it best to carry on the combustions in a closed tube, the substance being mixed with oxide of copper, as, if burnt in a boat in oxygen, the carbon was apt to come low, since the fused phosphoric acid prevented the complete combustion of the substance.

mula so far as they go, but need revision before much weight can be given to them.

Properties.—The substance crystallises in small white prisms apparently of the monoclinic system, or in long radiating needles, with, as far as we could determine, the same melting-point and composition as the prisms; it melts at 208°, and is insoluble in water, freely soluble in hot alcohol, less so in cold, essentially insoluble in ether. Potassic hydrate in aqueous solution does not act on it at first, but gradually decomposes it if the two are boiled together; sulphuric acid acts in the same way; the decomposition with hydrochloric acid has been described already.

Substance melting at 150°.—This compound was obtained at the very end of the term in an attempt to prepare more of the substance melting at 208°: on this account we cannot give the conditions which determine its formation, or anything more concerning it than the following analyses:—

0·3492 grm. of substance gave 0·7122 grm. of carbonic dioxide and 0·2004 grm. of water.

0·2562 grm. gave, according to Carius, 0·1330 grm. of argentic chloride and 0·0890 grm. of magnesic pyrophosphate.

	Found.
Carbon	55·62
Hydrogen	6·37
Chlorine	12·83
Phosphorus	9·70

It would not be worth while to attempt to determine the formula of this substance until these results have been tested by further analysis. It crystallises in rather thick white radiating needles, melts at 150°, and resembles the preceding substance in a general way in its solubility.

At no distant date we hope to be able to return to the study of this subject in order to determine the nature of the two substances just described, to investigate more thoroughly the products of the reaction, which are soluble in water, and to take up the compounds formed by aniline and phosphorus trichloride in presence of diluents, which, according to a preliminary experiment, promise to be of great interest.—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, November 3, 1884.

The Hon. Sir Wm. R. Grove, M.A., D.C.L., F.R.S., Manager and Vice-President, in the Chair.

Messrs. Charles Hartree and Robert Wilson, C.E., were elected Members of the Royal Institution.

William Miller Ord, M.D., was elected a Manager in the room of the late Right Hon. the Lord Claud Hamilton.

The presents received since the last meeting were laid on the table.

NOTICES OF BOOKS.

The Life and Works of Thomas Graham, D.C.L., F.R.S. Illustrated by 64 Unpublished Letters. Prepared for the Graham Lecture Committee of the Glasgow Philosophical Society. By Dr. R. Angus Smith, F.R.S. Edited by J. J. Coleman, F.C.S. Glasgow: J. Smith and Sons.

The substance of this work was to have been delivered as the second "Graham Lecture" before the Glasgow Philosophical Society. The severe illness of Dr. Angus Smith, however, compelled him to hand the manuscript over to Professor Ferguson, by whom it was read on the day appointed. Since the lamented death of the author it has been revised by Mr. Coleman, who has added a few explanatory remarks.

The work before us consists of two parts. The former of these is a life of Graham,—fragmentary, but exceedingly interesting, based to a great extent upon correspondence then in the possession of Dr. Angus Smith.

It appears that Graham showed a taste for experimental science, and that, like Darwin, he narrowly escaped the Church, which in the earlier part of the century was often the destiny of intellectual youths. He graduated at the University of Glasgow, and afterwards went to Edinburgh to continue his studies under Hope and Leslie. He writes:—"The Professors here are all at loggerheads with each other. Leslie calls Hope in his class-room 'the showman in the other corner,' while Hamilton has just received £500 damages from Hope for defamation." Concerning Hope we find the remark "I have heard him lecture once or twice, and set him down for a complete puppy." Of Leslie he writes:—"Although an excellent mathematician and natural philosopher (or as we should now say physicist), he is no great chemist."

About the year 1828 Graham, though doing valuable work, and fast rising in reputation, was much hampered by poverty. His sister, Mrs. Reid, communicates the following curious anecdote:—"I dare say you know of his taking a very poor little room at Portobello, and laying wires in the sea, mostly after dark, for his experiments. His landlady found some of his things below the bed in his room, and told him she did not like to see such things: she doubted he was after no good, and he had better take his leave. She put his wires, &c., out at the door, and bid him walk; she would rather want a week's rent than let him in again. So poor Tom had to hide his things and walk back to Edinburgh that night. The rent of the room was 3s. per week without fire, which was a great deal more than he could spare at that time."

After this little taste of the "Martyrdom of Science" we find Graham again at Glasgow, where he taught mathematics until, in 1830, he was elected Professor of Chemistry at the Andersonian University.

In 1836 he paid a visit to Muhlhouse, and made the acquaintance of Kœchlin, Schlumberger, and others of the Alsacian colonists. We catch here some amusing cross-lights as regards official science:—"I was amused at the feeling which seems to prevail here in regard to the French Institute (Academy of Sciences). They have never published Schlumberger's valuable papers on Madder, because they impugn the results of a brother academician, M. Robiquet, although Kœchlin spoke on the subject to Gay-Lussac, Chevreul, and others. The fact, I believe, is that this exclusive dealing results from no bad feeling; but the Institute is a coterie,—all the members are familiar with each other, and unwilling to give each other cause of offence. Gay-Lussac, likewise, who is chemical editor of the *Annales de Chimie*, is an exceedingly mild man, and is certainly carried too far by the fear of offending his brother academicians. There is one of my papers (on Phosphoretted Hydrogen) which he has promised to publish, but which I should not be surprised to find him restrained from doing when he finds that I give more credit to H. Rose than will be agreeable to M. Dumas."

After leaving France he went to Giessen, and spent two days with Liebig. Thence he went to Jena, to attend the German "Congress of Naturalists and Physicians."

Concerning Mitscherlich he writes:—"He has a most insinuating address, but there is a cold propriety in everything he says and does. I was sorry also to notice (and I made the same observation concerning Dumas) that when I stated any little discovery of my own he was fretted, and could not conceal a little disappointment, *because it had escaped him.*" This was not like the hearty good feeling of Liebig or H. Rose.

In 1837 Graham was appointed Professor of Chemistry

at University College—an appointment which he held for eighteen years. In the autumn of the same year he speaks of a reconciliation between Liebig and Dumas, and refers to the project of publishing a chemical journal in three languages, under the joint editorship of Liebig, Dumas, and himself.

In connection with Liebig's visit to England in 1844, we find mention of the then proposed College of Chemistry, which Liebig believed to be "a job of certain parties."

In 1855 Graham succeeded Sir John Herschel as Master of the Mint.

The remainder of the work consists chiefly of abstracts and titles of the numerous memoirs by Graham, as published in the *Philosophical Transactions*, the *Journal of the Chemical Society*, the *Philosophical Magazine*, &c. A question which has forced itself upon our mind whilst studying this work is, whether in the first half of this century Britain did not take a relatively higher standing in chemical science than she does at present? Some such idea seems to have occurred to Mr. Coleman, since we find him writing—"This completes the letters of Graham, who belonged to a group of chemists of the first rank, whose education and experience were acquired entirely on British soil, and, moreover, of a group of chemists whose powerful generalisations materially advanced the science throughout Europe."

The Alkali-Maker's Pocket-Book. Tables and Analytica Methode for Manufacturers of Sulphuric Acid, Nitric Acid, Soda, Potasn, and Ammonia. By G. Lunge, Ph.D., Professor of Technical Chemistry, Zurich, and F. Hurter, Ph.D. London: G. Bell and Sons.

The work before us is one of the most useful additions to our chemical literature which have appeared for a long time. In all countries where chemical manufactures are carried on there have been continual complaints of a want of uniformity in analytical methods and in tables employed in valuing chemicals. So long as different methods were in use among experts discrepancies in the results were always to be expected. Hence Herr Strof, manager of the Griesheim Alkali Works, proposed to the German Society of Alkali Makers that they should have published a standard manual of methods which all parties in the trade should adopt. Accordingly a committee of the most influential owners and managers of alkali works was appointed, and Prof. Lunge was requested to collect and elaborate the matter for the standard handbook. This choice of an editor was eminently judicious, and the general instructions given him are framed in the spirit of common sense. One method only was to be chosen for each analytical operation, as well as for preparing each standard solution and for sampling materials. So long as the chemist has his choice between two or more methods an element of discrepancy is never wanting.

The one method to be selected must above all things permit of a necessary degree of accuracy. If two or more methods were found equally accurate the preference was given to the one which occupied least time and required least apparatus. This selection of processes required involved not merely prolonged discussion but extensive trains of experimental research.

The standard tables of specific gravities of various saline solutions involved also much labour. For this purpose existing tables have been carefully verified and where necessary new ones calculated.

The German edition of this book has been very generally accepted by German alkali manufacturers, consumers, brokers, &c., as well as by commercial analysts.

The English edition contains chapters on Deacon's process and on chimney testing from the pen of Dr. Hurter, who has also re-calculated the tables in accordance with the English system of weights and measures. After a very careful examination we feel bound to express the hope that the tables, methods, &c., may meet with the same general acceptance which they have done in Germany.

A Course of Qualitative Chemical Analysis. By the late W. G. Valentin, F.C.S. Revised and corrected by W. R. Hodgkinson, PhD., and H. M. Chapman. Sixth Edition. London: J. and A. Churchill.

This work has proved such a general favourite that there is very little room for discussion as to its value. Nor has the present edition undergone any essential change of plan. It, may, indeed be asked whether a degree of prominence is not given to notation and to the doctrine of atomicity, scarcely called for in a manual of chemical analysis. The reactions of the rarer metals are given with exceptional care and accuracy.

Journal and Proceedings of the Royal Society of New South Wales for 1883. Edited by A. Liversidge, F.R.S. Sydney: Thomas Richards. London: Trübner and Co.

The Royal Society of New South Wales combines with its more legitimate functions those of a Society of Arts. Thus in the issue before us we find no fewer than three papers, occupying more than one-fifth of the entire transactions, devoted to irrigation. It must, of course, be remembered that in the climate of Australia irrigation is not, as in England, a mistaken whim, but the one thing needed to transform a desert into a garden.

In a paper on the "Roots of the Sugar Cane," by Mr. H. Ling Roth, it is shown that in light alluvial soils they may penetrate to a depth of 12 to 15 feet. This fact is of the greater practical importance, as in Porter's "Sugar Cane" (1843), they are said to be never more than a foot in length!

Dr. E. H. Rennie finds that the discolouration of white bricks made from certain clays in the neighbourhood of Sydney is due to the presence of vanadium. Whether this metal occurs in such proportions as to be industrially important the author has not yet ascertained.

A paper on the "Chemistry of Australian Products" consists of abstracts from the Chemical News, the *Journal of the Chemical Society*, the *Pharmaceutical Journal*, the *Comptes Rendus*, and other European sources.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 16, October 30, 1884.

Elementary Force of Solar Induction, the Periodic Duration of which is a Mean Day.—M. Quet.—The author puts forward the following general proposition:—The force of induction produced by any system whatever of electric currents upon a particle m of positive electric fluid is perpendicular to the relative velocity $o\,v$ of this particle, and to the direction $o\,d$ of the line of force which passes through the point o of the magnetic field. It is directed towards the left of the personified velocity and towards $o\,d$. Lastly, it is measured by the area of the parallelogram constructed upon $o\,v$ and $o\,d$: if f designates this force we have $f = m\,d\,v \sin e$, e being the angle $v\,o\,d$.

Disruptive Discharges of the Holtz Machine.—M. l'Abbé Maze.—On employing a Holtz machine the exciter of which is constructed so that a spark may be drawn at will to the right or the left of the axis of the apparatus,

it is found that the position to be given to the movable part of the exciter is by no means indifferent.

On Phosphorus Trifluoride.—H. Moissan.—Phosphorus trifluoride is a gaseous body obtained by causing very dry copper phosphide to react upon lead fluoride free from silica. At the temperature of −10°, and a pressure of 40 atmospheres, it is a colourless liquid which does not attack glass. The density of the gaseous trifluoride is 3·022. It is incombustible in presence of air, but if mixed with half its volume of oxygen it detonates on contact with the electric spark. It is slowly decomposed at common temperatures in presence of water.

Moniteur Scientifique, Quesneville.
Vol. xiv., October, 1884.

Manufacture of Superphosphates and of Precipitated Phosphate from a Theoretical, Analytical, and Practical Point of View.—M. Kienlen.—An extensive treatise incapable of useful abstraction.

Reversion of Phosphoric Acid.—T. S. Gladding.—Translated from the *American Chemical Journal* for March last.

Industrial Society of Mulhouse. Session of the Chemical Committee, July 10th, 1884.—Dr. Goppelsiræder announces that he has succeeded in discharging indigo-blues and turkey-reds by the electric current, using as an electrolyte solutions of chlorides mixed with caustic soda. The tissue saturated with these solutions is placed between two metal plates which serve as electrodes. The same chemist prints indigo as follows:—The calico is steeped in a mixture of finely ground indigo and a solution of caustic alkali. It is then placed on a metal plate forming one of the poles of the galvanic battery or of the dynamo-machine. Upon the cloth is then laid a second metallic plate forming the other electrode. At the negative pole the indigotine is converted into white indigo, with which the fibres become saturated. On taking away the upper plate, exposing the cloth to the air, and washing strongly, it is found to be dyed an indigo-blue as fast as that obtained by the ordinary process. The hydrogenation of indigo by the galvanic method only takes place imperfectly in the cold. Heat is needed to effect a rapid reduction. A prolonged action of the current destroys the indigo.

MM. Yung and Rudolf sent in a note on a process for determining indigo by measuring the quantity of air absorbed by a reduced solution. The details are not published.

M. H. Kœchlin communicated a new method of fixing chromium oxide, founded on the property of alkaline solutions of chrome of giving up their oxide to organic fibres on being left in contact for some hours, without occasion for drying. Thus, if cotton is steeped in a mixture of 2 parts acetate of chrome at 16° (probably Beaumé), 2 parts caustic soda at 38°, and 1 part of water, and washed after twelve hours, the mordanting is complete.

M. Schmid criticised the views of Müller-Jacobs on the "sulpholeates," and showed that the presence of a triglyceride in turkey-red oils is not necessary.

Notes on the Mouras Closets.—In these closets the fœcal matters are conducted into air-tight tanks, previously filled with water. No chemicals are employed, but the water is said to liquefy and digest paper, textile matters, and fatty bodies. The effluent water has the same specific gravity as pure water, and has an odour *sui generis* but decidedly supportable. It may either be passed into the streams or used for irrigating meadows.

Foreign Patents having Reference to the Chemical Arts.—Specifications of patents for the continuous electrolytic production of magnesium; for improvements in the electrolysis of the haloid salts of the light metals, and for the preparation of tetra-hydro-paraquin-anisol.

Decree on the Question of Salicylised Wines.—The result of an action against a merchant of Bordeaux for having imported 967 hectolitres of wine containing salicylic acid.

Foreign Patents for the Preparation of Colouring Matters.—Specifications for the use of chlorinised formic ether in place of carbon oxychloride; for the preparations of double compounds of iodine chloride, with the bases of the quinoleic series; improvements in the preparation of violet colouring matters by the action of carbon oxychloride upon tertiary aromatic monamines, and preparation of azo-colours by means of alpha-naphthol-disulphonic acids.

Revue of Organic Chemistry.—Abstracts from the *Berichte der Deutschen Chem. Gesellschaft.*

Justus Liebig's Annalen der Chemie,
Vol. 225, Part 1.

Sulphur Compounds of Molybdenum.—Gerhard Krüss.—The author here describes sodium monosulphomolybdate, ammonium disulpho-molybdate; the corresponding potassium salt; primary ammonium pyrodisulpho-molybdate, and the analogous potassium and sodium salts; potassium sulpho-molybdate; normal ammonium sulpho-molybdate; basic potassium sulphomolybdate. He gives some remarks on the spectral analysis of the oxysulpho- and sulpho-molybdates, and describes primary potassium persulpho-molybdate and persulpho-molybdic acid, which is the first free inorganic sulpho-acid the existence of which has been positively proved.

On Hydro-para-cumaric Acid.—C. Stöhr.—This acid, which occurs in rhubarb, has also been prepared synthetically. With nitrous acid it gives the phenol reaction. If the pulverised acid is covered with strong sulphuric acid it gradually dissolves with a transient red colouration. On adding a trace of sodium nitrite it becomes a deep brownish red, which on dilution with water turns to a deep gold-yellow, and on heating becomes a pure green.

On Quinine and Homoquinine.—O. Hesse.—The author refers to his discovery that quinine does not occur exclusively in the Cinchonaceæ, but is met with in a bark formerly called *China cuprea*, but now identified as *Remijia pedunculata*. In this plant it is not accompanied by cinchonidine, but often by homoquinine. The author concludes that homoquinine is a modification of quinine, present in many specimens of *China cuprea*. There are several modifications of quinine which on suitable treatment pass into ordinary quinine.

Researches on the Specific Volumes of Liquid Compounds.—W. Lossen and A. Zander.—Not capable of useful abstraction.

Cosmos les Mondes.
No. 3, September 27, 1884.

Lord Rayleigh is accused of having in his introductory discourse at the Montreal meeting "almost forgotten the researches of French physicists."

The well-waters of Asnières, Clichy, La Chapelle, and Saint-Denis are poor in oxygen, rich in nitrogenous organic matter, and contain more than 2 million bacteria per litre.

Prof. W. R. Nichols, in *Sanitary Engineering*, shows that sand has a very slight filtering power, and differs in its action *toto cœlo* from animal charcoal.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Tome xi., July, 1884.

On Panary Fermentation.—From the *Comptes Rendus.*

Causes of Chemical Changes in Flour.—M. Balland.—Also taken from the *Comptes Rendus.*

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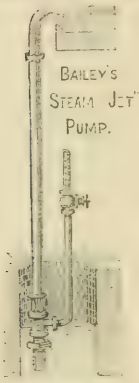

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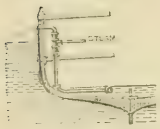

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THE CHEMICAL NEWS.

Vol. L. No. 1303.

COMPOSITION OF THE ASH OF STRAWBERRIES.

By JOHN M. H. MUNRO, D.Sc., F.C.S.

During last summer I took an opportunity of determining the composition of the ash of a sample of ripe strawberries, grown in the field by a Kentish fruit-grower. 256 grms. of the ripe fruit, deprived of the stalks, yielded on prolonged drying at 100° 27·38 grms. dry matter, which, after careful incineration, left 1·10 grms. ash. The strawberries therefore contained :—

Water	89·30
Organic matter	10·27
Ash	0·43
	100·00

The composition of the ash was as follows :—

Sand and insoluble matter..	6·61
Phosphate of lime	23·91 containing 11·70 P_2O_5.
,, ,, magnesia ..	trace
Carbonate of potash	60·77 containing 41·40 K_2O.
Magnesia	2·93
Soda	1·29
Sulphuric acid (SO_3).. ..	3·88
Undetermined	0·61
	100·00

It seems evident from the above figures that in the strawberry the whole of the potash exists in combination with organic acid, and the whole of the phosphoric acid as phosphate of lime. The quantity of potash present is very considerable, even when compared with that contained in the grape. I am informed by strawberry growers that when the plants forced in pots are grown with the aid of guano or very rich soil, it is generally found that although many blossoms are produced they do not all set, or if they do the fruit is inferior in size and quality to the smaller quantity produced by less vigorous plants grown in poorer soil. The stronger and more highly forced plants are also found to be more liable to mildew.

Considering the benefit often derived by the vine from applications of potash manures, it seems at least possible that a special manure containing a fair proportion of potash would produce good results with strawberries grown in pots and with other fruits forced under similar circumstances. The experiment may have been tried here and there, but not, so far as I can learn, by growers of fruit for the market.

College of Agriculture, Downham, Salisbury.

ON THE DETECTION OF CYANIDES IN THE PRESENCE OF COMPOUND CYANIDES.

By W. J. TAYLOR.

Cyanides, when in the presence of compound cyanides, cannot well be detected by any of the ordinary methods. Thus, for example, a mixture of potassic cyanide with ferrocyanide will, when distilled with a very dilute acid,—sulphuric, hydrochloric, or even acetic,—behave in the same way as a solution of the pure ferrocyanide alone; I find that both solutions yield hydric cyanide, which, when received in ammonic sulphide, readily forms sulphocyanide, giving the well-known reaction with ferric chloride.

It is accordingly necessary to find a substance which, while freely decomposing the cyanide, will, at the same time, leave the ferrocyanide untouched. This condition is fulfilled by hydro-sodic carbonate.

Substituting this carbonate for either of the acids used in the above experiments, a 10 per cent solution of potassic ferrocyanide was left undecomposed, no trace of the red colouration being given with ferric chloride, while, at the same time, a $\frac{1}{100}$ per cent solution of potassic cyanide gave the reaction perfectly, 0·002 grm. being thus very easily detected.

Mercuric cyanide is somewhat refractory, not giving the colouration if treated with the carbonate alone; but if, in addition, some clean metallic zinc be taken, the colouration is at once seen.

For this purpose 20 c.c. of a $\frac{1}{100}$ per cent solution of mercuric cyanide was distilled with 2 grms. of carbonate and 5 grms. of zinc. The first c.c. was distilled over, treated as before, and the blood-red colouration was readily observed.

Potassic sulphate, potassic ferricyanide, potassic sulphocyanide, and ammonic salts do not interfere with the reaction.

In the detection, then, of cyanides in presence of compound cyanides, all that is required in qualitative analysis is to distil with an adequate volume of water, and an excess of hydro-sodic carbonate: if the preliminary examination shows that mercury exists in the mixture, a few grammes of zinc must be added.

This method of detection will probably be found of value in medico-legal investigations. Moreover, as it ends with the formation of a coloured liquid, it can obviously be made quantitative—or at least approximately so—by comparative experiments with the colorimeter.

Glasgow, November 5, 1884.

ANHYDROUS ANALYSIS.

By Lieut.-Col. W. A. ROSS, R.A., F.G.S.

Anhydrous analysis may be described as the chemical separation of inorganic substances, combined as in a mineral, by means of apparatus and reagents absolutely free from water. This expression of objects desired necessarily implies (*a*) that the processes may be made quantitative; and (*b*) that results are obtained by the direct application of fire to the assay, without any metallic or other interposition, as the "wall" of a crucible.

The most convenient, and indeed as far as yet known the only, way of thus applying fire in a sufficiently pure and concentrated form, is by means of the little chemical instrument invented by the Swedish mine-master, Von Svarb, in 1731; described in a series of lectures on Assaying, delivered in Leyden by a Scotchman (Cramer) in 1737, published in a Latin book at the same place in 1741, and figured for the first time in Von Svarb's own treatise on results obtained by him, misappropriated by Cronstedt, translated into English by Von Engeström, and published under the name of the latter in London, in 1770. The simplicity of the instrument by which such varied and important effects can be produced may be inferred from the name given it by civilised scientific nationalities,—the French calling it simply a reed or pipe (*chalumeau*); the Germans, a soldering-pipe (*löthrohr*); and the English, a blowing or blowpipe.

It is, in fact, nothing more than a wind-pipe attached to human lungs or artificial bellows, having an elastic air-reservoir, such as human cheeks, to prevent re-absorption of delivered air by the bellows whilst distending, and a "jet" or issue-passage of comparatively minute bore. The effect

of applying the minute but energetic current of air or blast, thus afforded, to an ordinary hydrocarbon flame, as that of a candle, is exceedingly curious and unexpected: the luminous, upright, elliptical *flame* disappears as by magic, and is instantaneously replaced by a non-luminous horizontal *cone* of dark blue light. The cause of this strange metamorphosis has been explained as follows:—The blast, which cannot penetrate the candle-flame, blowing it down therefore on its side, creates a vortex in the surrounding air; this vortex sucks in the prostrate flame, converting it necessarily to its own shape, of a cone with a vertex as fine as the point of a sewing-needle; and all this is effected so rapidly that the eye cannot follow the details of change.

If this explanation be correct (and no other has ever been offered of the above-mentioned well-known phenomena) it would appear that the laws governing the application of vorticose air to flame might be used with advantage and economy of fuel, in operations on the large scale, as in Metallurgy.

The process of testing minerals, &c., with Von Svarb's blowpipe, assisted by solid, fusible, and portable salts,—as borax, microcosmic salt, sodium carbonate, &c.,—was exceedingly improved in every detail by Assessor Gahn, and finally carried to great perfection by Professor C. F. Plattner, of Freiberg, and it maintains a position in the *curricula* of most mining colleges of Europe (except English), and of America to this day; but it is a great and obvious error to call such work "blowpipe *analysis*," inasmuch as there is not even a pretence of *separation* in the matter.

If, however, we treat mineral powders with the point of the blue cone of fire or pyrocone above described, not in borax, but in its acid constituent "boron trioxide," or, as it was formerly called, "boracic acid," a *bonâ fide separation* into pyroborates of different form, colour, and weight takes place in most cases after a few minutes treatment.

Alkali or alumina contained in the mineral exercises a dissolving effect upon assays, by boric acid before the blowpipe, and therefore has the result of mixing such separated borates together again, by dissolving them therein; but by previously fusing the mineral containing these ingredients by means of its own alkali, or with the addition of a little soda, on aluminium plate before the blowpipe, then boiling for a few seconds the fused crushed mass in distilled water (by which the alkali is removed), and, lastly, treating the dried residual powder in boric acid again,—or, in the case of alumina, in phospho-boric acid,*—separated borates or phospho-borates are once more obtained. Thus fusible or zeolitic silicates, which generally afford a jelly to hydrochloric acid, afford also a jelly to boric acid before the blowpipe, only of course much more quickly, and, having been thus rapidly identified as to their general nature, can be afterwards *analysed* as above described.

The only drawback to the efficiency and general practical utility of this new system of analysis is the small scale upon which these chemical separations are at present necessarily effected by means of "beads" before the mouth blowpipe, or hand or foot blower. But it will be evident to the philosophical or physical chemist (and what real chemist is not philosophical?) that the laws of Nature being unalterable on any or every scale, by the employment of a much higher temperature, with properly supported masses of anhydrous reagent (instead of beads on platinum wires), analytical results of almost any size desired—or, at all events, large enough to be weighed in the biggest assay-balances—would be obtained.

It is known, for instance, if a mass of pure fused boric acid, the size of a hen's egg, were placed upon a solid block or cube of aluminium, and treated with mineral powder before an oxy-hydrogen blowpipe, that definite spherical borates or pyroborates of the following metals, large enough to be weighed in any balance, could be, in an extraordinarily short space of time, obtained by simply boiling the mass in distilled water:—Barium, cadmium, calcium, cerium, cobalt, copper, didymium, erbium, iron, lanthanum, magnesium, manganese, strontium, zinc.

Again, it is all but settled practically that pure silica or rock crystal, being an acid substance chemically analogous to boric acid, would, if treated as a reagent before the oxy-hydrogen blowpipe (which rapidly fuses it) upon the same support, yield definite silicates analogous to the above-mentioned borates; and thus the chemist would have the pleasure of producing Nature's own products in his laboratory, at the very same time, and by the same process, through which he was enlarging and developing artificial science.

Not having sufficient means to carry out such important experiments myself, I would most respectfully ask the authorities of the following Colleges to do so in the cause of scientific research:—The Royal School of Mines; The London City and Guilds Institute; Owens College, Manchester; The Imperial Mining Academy, Berlin; The Royal University, Freiberg; The French Mining Academy, Paris; Yale College, New Haven, U.S.A.; Columbia College, New York; The College of New Jersey, Princeton, U.S.A.; The Polytechnic Institute, Troy, N.Y.; McGill College, Montreal. Perhaps the following extract from the review of a lately-published popular book of mine on this subject, translated from the "Berg und Hüttenmännischen Zeitung," of which Prof. Bruno Kerl, Imperial Mining Academy, Berlin, is co-editor, may offer some inducement to take the matter up.

"*The Blowpipe in Chemistry, Mineralogy, and Geology.*

"The author of this work, well known beyond the bounds of his native country by his original works on the art of Blowpipe Analysis, furnishes in the volume before us a new contribution to this science, and gives instructions for the simplest and most efficient methods of determining the chemical nature of inorganic substances, of which only a small quantity is obtainable.

"In consequence of these discoveries blowpipe analysis will become an important factor in the eventual and complete study of chemistry, metallurgy, mineralogy, and geology.

"Besides these novel processes of the author, now familiar to German chemists, many new points of departure from old methods are taken, new reactions and tools described, and surer means of discrimination afforded, by means of a clear and instructive text, copiously illustrated throughout by well-executed wood engravings.

"In twelve chapters are treated—The manufacture of blowing apparatus; the construction of lamps, supports, auxiliary apparatus, and tools; structure and nature of the flame; reagents, special reagents, (boric and phosphoric acids, calcium borate), &c., &c. . . .

"It would be a grateful task to translate this important work into German."

THE ARTIFICIAL PREPARATION OF OPTICALLY ACTIVE SUBSTANCES.

Chemists generally assume that all chemical substances can be made in the laboratory by artificial methods, and certainly when we consider the many syntheses of natural substances that have been effected during the last thirty years, the assumption appears to be justified. Nevertheless, there are some facts which speak against it. Several of the vegetable acids have the power of turning the plane of polarised light either to the right or left. Some of these substances have been prepared artificially, and the products thus obtained have been shown to have all the properties of the corresponding natural substances with the exception of the optical activity. Thus natural malic acid is lævo-rotatory, while the malic acid obtained from

* Made by dipping the red-hot boric acid bead into pure, deliquesced, phosphoric acid.

brom-succinic acid is optically inactive. Such facts have led gradually to the conclusion that artificially prepared substances cannot act upon polarised light, that in order to get an optically active substance we must have the intervention of the life process.

Finally, however, Perkin and Duppa succeeded in making racemic acid from bibrom-succinic acid, and Jungfleisch and Pasteur showed that this artificially prepared racemic acid could be split up into dextro- and lævo-tartaric acids. Thus the artificial preparation of one optically active substance was certainly accomplished, and, while some chemists concluded that the same result would probably in time be reached in connection with all optically active substances, others preferred to suspend judgment and await further developments.

Last December, M. Pasteur in a lecture* before the Paris Chemical Society, called special attention to the subject. The lecture has given rise to an interesting discussion between MM. Wyrouboff, Jungfleisch, and Pasteur, the substance of which, together with two papers on the subject by M. Jungfleisch, are published in the *Bulletin de la Société Chimique de Paris*, vol. xl., No. 5 (March 5, 1884). In view of the interest which the subject must have for all chemists, abstracts of M. Pasteur's lecture and the other papers referred to are here given. M. Pasteur began his lecture by describing in detail the crystallisation of the double racemate of ammonium and sodium, and the formation of the two kinds of crystals from it. To use his own words: "A new idea soon occurred to me. These crystals, asymmetric to the right, which I could separate mechanically from the others, proved to be identical in form with those of the dextro tartrate. . . I separated these right-handed crystals from the crystallised racemate; I made the lead salt and isolated the acid. This acid was absolutely identical with the tartaric acid from grapes, and, like it, acted upon polarised light. I was still happier when, on taking in turn the left-handed crystals obtained from the racemate, I obtained a tartaric acid quite similar to ordinary tartaric acid, but having a form asymmetrical in the opposite way, and acting in the opposite direction upon polarised light. The form was identical with that of the image of dextro-tartaric acid placed before a mirror. The principles of '*molecular asymmetry*' were thus founded. There are substances of which the atomic grouping is asymmetrical, and this grouping shows itself in an asymmetric form and in an action upon polarised light; besides, these atomic groupings have their possible complements, the forms of which are identical with the images of the first, and with an opposite action upon polarised light. . .

"Now, gentlemen, there is one strange peculiarity about this molecular asymmetry. We find asymmetry established in a very large number of the proximate principles of animals and vegetables, notably in the proximate principles essential to life. All the products, so to speak, of the egg and the seed are asymmetrical.

"There are, without doubt, in animals and vegetables proximate principles, such as urea and oxalic acid, which are not asymmetrical; but these are secondary products, comparable in one sense to our laboratory products, which are not asymmetrical.

"In other words, when a ray of sunlight strikes a green leaf, when the carbon of carbonic acid, the hydrogen of water, the nitrogen of ammonia, and the oxygen of the carbonic acid and of the water form chemical compounds, and the plant grows, the bodies which are thus developed are asymmetrical. You, however skilful chemists as you are, though you bring together the same elements in a thousand different ways, always make products without molecular asymmetry. As far as I know, there does not exist a single product of chemical synthesis, formed under the influence of causes which may be considered peculiar to vegetable life, which is not asymmetrical. . . On the other hand, there is not a single product of synthesis prepared in the laboratory or in dead mineral nature which is not symmetrical."

* *Revue Scientifique*, Jan. 5, 1884.

The speaker then referred to the synthesis of racemic acid from bibrom-succinic acid, and the splitting up of this artificial product into dextro- and lævo-rotatory tartaric acids. He denied that this synthesis disproved his statement that optically active substances cannot be prepared synthetically. He quoted the words of Le Bel, as follows:—"It is then not only vegetable life which includes cases of asymmetry, and the line of demarcation between vegetable and mineral chemistry pointed out by M. Pasteur does not exist." To this he remarked: "That is an error. I claim to be able to show you that this separation, this barrier, is on the contrary confirmed by the results first observed by myself, and afterwards by M. Jungfleisch and by M. Le Bel.

"We can explain the facts regarding asymmetry in the following manner:—When the proximate principles which are essential to life are formed, it is under the influence of asymmetrical forces, and that is why life produces asymmetrical substances. When the chemist in his laboratory combines the elements or compounds formed from the elements, he does not bring into play the asymmetrical forces. That is why all the substances which he produces by synthesis are devoid of asymmetry. . . . You ask: What then are the asymmetrical forces which preside over the elaboration of the proximate principles of nature? It would be difficult for me to answer with accuracy; but asymmetry I see everywhere in the universe. The universe is asymmetrical. . . . You in your laboratories, with your solvents, your heat and cold, have at your service only symmetrical forces. Is there then an absolute division? Certainly not. Far from saying or thinking so, I first pointed out the means which we might make use of to destroy the barrier. What must we do to imitate nature? We must break loose from our methods, which are from this point of view antiquated and impotent. We must try to bring into action the asymmetrical forces, we must have recourse to the action of the solenoid, of magnetism, of the asymmetrical motion of light, to the action of substances which are themselves asymmetrical. When, carried away by inexorable logic, I passed from researches in crystallography and molecular chemistry to the study of ferments, my thought was to introduce asymmetry into chemical phenomena. . . . On bringing together cinchonine, an active asymmetrical substance, and racemic acid, I saw the cinchonine salt of lævo-tartaric acid deposited, while the dextro-tartrate remained in solution. With an inactive body, racemic acid, I have made lævo- and dextro-tartaric acids. Although I was the first to imitate nature in its methods, and to show the analogy between natural and artificial products, I am careful not to conclude that the barrier between the two chemistries is destroyed. On the contrary, I conclude that the experiment of which I have spoken establishes the proposition, namely, that the forces brought into play in our laboratories differ from those to which vegetable nature is subject.

"In another way, much more interesting, I have introduced asymmetry into chemical actions. I have shown that ammonium racemate can ferment under the influence of microscopic fungi, and that lævo-tartaric acid appears. The dextro-tartrate is decomposed, the lævo-tartrate remains intact. With an inactive racemate I have caused the appearance of simple asymmetry, but why? Because the little ferment is a living body formed of a collection of asymmetrical products, and because for purposes of nutrition the little being finds the dextro-tartrate better adapted than the lævo-tartrate.

"I have gone further: I have caused to grow on the surface of ashes and racemic acid, some grains of of *Penicillium glaucum*, that mould which is found everywhere, and I have seen lævo-tartaric acid appear. Here again we have a case of simple asymmetry obtained from an inactive body; but in order to reach this result, it has been necessary, you see, to cause the intervention of the actions of asymmetry, the asymmetry of the natural proximate principles which go to make up the grain of mould.

"These are precisely the methods made use of by M. Le Bel in extracting from his racemates the simple active products. He had recourse to the employment of an asymmetrical substance or of a mould or a microbe.

"Further, these experiments indicate the existence of a line of demarcation between the mineral kingdom and the organic kingdom, since to imitate what nature does, that is to prepare a right-handed or left-handed body, we are obliged to make use of peculiar kinds of action, of the action of asymmetry. The line of demarcation of which we speak is not a question of pure chemistry, of obtaining such and such products, it is a question of forces; life is governed by asymmetrical actions." . . . In a note M. Pasteur adds these words: "I am convinced that the double racemate of sodium and ammonium would not of itself under ordinary circumstances break up during crystallisation unless an asymmetric force were present, and if this is not an action of light or magnetism, I can readily believe that the force is due to some asymmetrical organic dust on the surface of the vessel in which the crystallisation takes place. Nothing would be simpler than to crystallise a solution of sodium ammonium racemate with perfect exclusion of all organic dust. Under such circumstances the unchanged racemate should be obtained."

Discussion.

M. Wyrouboff said that the theories put forward by M. Pasteur with so much conviction and talent, in his lecture, appeared to him to be opposed to all that is known to us regarding the properties of crystallised bodies. The theories are based upon a fundamental hypothesis, according to which natural (chemical) phenomena are subject to two kinds of action, symmetrical and asymmetrical; the former governing in the mineral kingdom and in the synthesis effected in our laboratories, the latter pertaining to the life process.

Asymmetrical bodies may be arranged, as is known, in two well characterised classes. Those of the first class, like quartz, sodium chlorate, benzil, cinnabar, are asymmetrical either in their internal structure and their external form, or only in their internal structure, no hemihedral face accompanying the rotatory power. All these bodies can be prepared artificially by starting with the elements; hence we must admit, looking at the matter from M. Pasteur's standpoint, that in our laboratories we have at our disposal at least some of the asymmetrical actions which he attributes exclusively to life; for, how shall we explain, by the aid of symmetrical actions alone, the existence of plagihedral faces of crystals and their relation to the rotatory power?

"The second category includes those bodies which are not asymmetrical in their internal structure, but have asymmetrical external forms and integrant molecules, or only the latter, for, between the rotatory power of the solution and the hemihedrism of the crystals, there is not that simple and necessary relation which was supposed to exist when only a few facts were known. These bodies have the rotatory power only in solution, and retain the power in all the compounds into which they enter. They are asymmetrical neither more nor less than the bodies of the first category; they are asymmetrical in a different sense.

"The bodies which have molecular asymmetry are the ones which M. Pasteur had in view when he asserted that they cannot be prepared synthetically.

"It should be remarked in the first place, that, among the great number of compounds which chemists have prepared synthetically, only very few have been studied crystallographically and examined with the polariscope. In the second place, the assertion is contradicted by the facts: racemic acid has been prepared synthetically, and it has been split up into dextro-rotatory and lævo-rotatory tartaric acids. To this proof, so clear and definite, M. Pasteur replies by suggesting a new hypothesis. He asserts that we really have to deal with some action of the asymmetrical order, some spiral movement, some magnetic influence, some organic dust, and he adds: 'Nothing would be simpler than to crystallise a solution of sodium ammonium racemate with perfect exclusion of all organic dust. Under such circumstances the unchanged racemate should be obtained.' But what is the object of trying this experiment, when we consider that twenty years ago the racemate of the formula $C_4H_4Na(NH_4)O_6+H_2O$ was prepared by M. Scacchi, who, in an admirable memoir, gave the exact conditions of its formation? He showed that the spliting of the acid was occasioned only by the fact that the double ammonium sodium salts of the two tartaric acids are less soluble than the mixture of the two; that in elevating the temperature, the solubility of the dextro acid increases more rapidly than that of the lævo acid, and that there is a limit beyond which the mixture, becoming less soluble, the racemate alone is deposited. The phenomenon is so perfect that we can get at will from the same solution, properly concentrated and containing an excess of ammonium carbonate, either the racemate, or ammoniacal Seignette salt, or crystals of both at the same time. It is only necessary to vary the temperature between 17° and 26°. The racemate of sodium and potassium conducts itself differently: at 26° it always spilts up; below this temperature it deposits sodium racemate, then Seignette salt, finally sodium racemate, each one of the deposits corresponding to the solubility of the salt, as M. Scacchi has shown.

"With sodium thallium racemate the case is still different. M. Wyrouboff has recently prepared this salt, and will soon describe its form. Seignette salt containing thallium crystallises, as is known, between 20° and 25° in voluminous soluble crystals in about half their weight of water. Neutral thallium racemate requires at these temperatures about nine parts of water to dissolve it; neutral sodium racemate about 2·5 parts.

"According to M. Pasteur, it would be impossible to say beforehand whether or not the racemate will be split into the detro- and lævo-tartrates, the splitting being a result of mysterious forces acting asymmetrically.

"Nothing is easier, however, than to foresee the course of the phenomenon, if it really depends upon the greater or less solubility of the compounds taking part in the crystallisation. On evaporating at 25° we ought not to get the double tartrate; nor even the double racemate, unless it is—what it is not—less soluble than the neutral tartrate of thallium; we could get only thallium racemate; later, after the liquid is further concentrated, a little of the double racemate, and lastly, sodium racemate. This indeed is what is always observed. And it is so clearly a matter of solubility, that we may get the double racemate of sodium and thallium by two methods, apparently different, but based upon the same principle: we can crystallise the mixture at an elevated temperature, 40° for instance, or at the ordinary temperature, adding an excess of sodium racemate.

"Finally, we have the double racemate of sodium and rubidium, which under the proper conditions always breaks up at ordinary temperatures, and the two simple salts separate at higher temperatures.

"These examples enable us to solve without difficulty the general question as to the causes of the splitting of the racemates, which appear so complex and so mysterious to M. Pasteur, and which is nevertheless so simple. Why do not all the numerous racemates, simple as well as double, known up to the present time, yield tartrates? Why is this action confined to the double salts of sodium, with potassium, ammonium, and rubidium? Because, in these cases alone, one of the tartrates taken separately is less soluble at the ordinary temperature than the mixture of the two.

"We may hence state these rules, to which up to the present there are no exceptions known:—

"1. *Every racemate having a solubility less than that of the corresponding tartrate splits up.*

"2. *Every racemate which is more soluble than the corresponding tartrate does not split up.*

"Finally, concerning the case of double racemates, and this applies to double salts of all possible acids:—

"3. *When two simple racemates, which are allowed to crystallise together, have very different solubilities, they are deposited separately. To get the double salt, the proportion of the more soluble salt must be increased.*

"The solubility being a function of the temperature, it is clear that these rules are valid for any given compound only at a definite temperature."

Apropos of the communication of M. Wyrouboff, M. Jungfleisch cited a number of facts which have led him to the opinion that the separation or non-separation of inactive bodies into their constituents is a result of the relations which exist between the solubilities. Thus, in a solution of sodium ammonium racemate, the dextro-tartrate resulting from the splitting up shows itself to be less soluble than the lævo-tartrate. Some experiments have indicated that differences of the same kind exist between the two active tartrates of sodium and potassium. Besides, it is known that the corresponding racemate obtained by M. Delffs was deposited in the neighbourhood of 0°. Further, we may recall the tartrates of cinchonine of M. Pasteur: the marked differences which exist between their solubilities suffice to explain their separation. Finally, the phenomena observed by M. Jungfleisch on para-camphoric acid furnishes new insight from this point of view: during the cooling of a warm solution of this body between 80° and 40°, principally the lævo acid is deposited, while the dextro acid predominates in the crystals formed below 40°; the solubility curves are so different that the two optically active acids can be separated by fractional crystallisation. If the mother-liquor is allowed to stand in the cold, para-camphoric acid is again formed.

M. Pasteur's Reply to M. Wyrouboff.

"I am very much surprised that M. Wyrouboff should have confused molecular asymmetry and the asymmetry in the arrangement in a crystal. Is not the difference between the two kinds of asymmetry demonstrated by the fact that fused quartz dissolved, sodium chlorate dissolved, strontium formate dissolved, have no action on polarised light; that, on the other hand, an asymmetrical crystal, right or left handed, of one of these substances, as sodium chlorate for example, gives, when crystallised, two sorts of hemihedral crystals?

"M. Wyrouboff objects to the hypothesis which I suggested in a note concerning my communication to the Chemical Society on the 22nd of December, which was to the effect that the splitting of sodium ammonium racemate may be caused by organisms in the solution or on the crystallising dishes. As far as I am concerned that is merely a preconceived notion, but I give it for what it is worth. *A priori* ideas, hypotheses, with all due deference to my opponent, are essential to scientific progress.

"If the experiment which I have referred to should not prevent the splitting of the racemate, I shall try whether the splitting may not be due to some other cause equally asymmetric; for example, light or terrestrial magnetism.

"M. Wyrouboff seems to think the matter is settled when he assures that the conditions of the formation of the racemate and of the splitting of the racemate are now well known, and that they depend upon the greater or less solubility of the salts. But M. Wyrouboff, in my opinion, seems not to comprehend the fact that the formation of the racemate is only perfectly natural, as all the racemates, with one exception, occur only as such; what is exceptional is that one racemate should split up. I cannot consider the opinion reasonable that finds the cause of the splitting in an influence of solubility. Why does the racemate of sodium and ammonium deposit crystals of two kinds? why does it give rise to the formation of complementary tetrahedrons? Why do these two tetrahedrons exist, and why not the octahedron which corresponds to them, which octahedron would have the solubility of the tetrahedral crystals? These facts, according to my idea, require explanation. I shall continue to believe, as long as I am not shown to be wrong, that the splitting can take place under the influence of asymmetry.

"M. Wyrouboff, in another part of his remarks, calls my attention to the existence of bodies which are active towards polarised light, but which nevertheless have no asymmetry of form. He who reproaches me for not understanding the subject appears not to be aware that I have formerly examined into this fact with much care, and that I have shown that it is easy, by means of artifices in crystallisation, to cause the appearance of asymmetric faces whenever internal molecular asymmetry exists. I cited the case of tartramide, the crystals of which formed in pure water never have hemihedral faces, but which show these faces when they are deposited from an ammoniacal solution. I cited the case of ammonium bimalate, which in crystallising from pure water never has hemihedral faces, and which has them when the liquid in which the salt crystallises is changed by a very simple process to which I refer.

"M. Wyrouboff makes a great deal out of the following fact:—On adding ammonium citrate to ammonium (dextro) tartrate, the hemihedral faces appear on the other side of the crystal, and inversely for the lævo-tartrate, and, he adds, the hemihedrism may be made to disappear entirely. But this is only one of the accidents of crystallisation of which I have given many examples; I have proved that crystals of right-handed Seignette salt are sometimes met with which have left-handed hemihedral faces. A crystal may have a number of secondary forms. The hemihedral faces make a part of the secondary forms, and these show themselves or are absent according to the conditions of temperature, of the medium, &c., &c. One cannot see why the external conditions of crystallisation should not overcome the influence of the asymmetric agency upon the internal structure of the molecules."

Experiments of M. Jungfleisch.

M. Jungfleisch describes some new experiments which tend to show that the dextro- and lævo-tartrates of sodium and ammonium have different solubilities in a solution of a mixture of the two salts. He introduced into a supersaturated solution of the racemate a right-handed crystal and a left-handed crystal. The two salts were deposited at once. The crystals were weighed in a number of cases, and constant results were obained. The following examples will iudicate the character of these results:—

I. Experiment with 1545 grammes racemic acid.
   Crystals of the first deposits: left, 557 grms.; right, 585 grms.
   Crystals of the last deposits: left, 581 grms.; right, 569 grms.

II. Experiment with 1500 grammes racemic acid.
   Crystals of the first deposits: left, 561 grms.; right, 577 grms.
   Crystals of the last deposits: left, 533 grms.; right, 488 grms.

In another case, starting with 2 kilogrammes of racemic acid, successive deposits were obtained as follows:—

First crystallisation: lævo salt, 375 grms.; dextro salt, 400 grms.
Second crystallisation: lævo salt, 160 grms.; dextro salt, 181 grms.
Third crystallisation: lævo salt, 165 grms.; dextro salt, 190 grms.
Fourth crystallisation: lævo salt, 115 grms.; dextro salt, 115 grms.
Fifth crystallisation: lævo salt, 185 grms.; dextro salt, 150 grms.

In all the experiments the right-handed salt is at first deposited in greater quantity than the left-handed; its solubility is hence less than that of the left-handed salt. Inversely, in the second phase of the crystallisation, the left-handed salt appears more abundantly than the right-handed.

Further, when a solution of sodium ammonium racemate is concentrated to such an extent that, on cooling, it deposits about half of the mixture of the two tartrates which it can yield, it is found that the mother-liquor has a rotatory power to the left—slight to be sure, but quite sufficient to be easily observed. Hence the left-handed salt exists in the mother-liquor in larger quantity than the right-handed salt; it is more soluble than the latter.

M. Jungfleisch finally states that the discussion between himself and M. Pasteur is based on a misunderstanding, M. Pasteur wishes to make a simple active body without passing through a body inactive by compensation, that is decomposable into right and left-handed substances; he wishes not simply to make racemic acid, which is decomposable into the two active tartaric acids, but to make directly a single one of the two latter. M. Pasteur wishes to follow the method of nature, which produces the dextro-acid and not racemic acid. This seems to M. Jungfleisch to be an entirely distinct problem, and it has not been solved up to the present, though the preparation of an optically active substance by methods independent of the life process has been accomplished. He is willing to go further, and say that the problem of imitating the processes of nature has been solved neither for optically active nor for optically inactive substances. "The time when M. Berthelot established the possibility, till then denied, of producing synthetically the natural proximate principles is still not far removed; and although the results obtained in this way are as important as they are numerous, the state of Science does not yet enable chemists to copy the actual *processes* of nature. Though M. Berthelot, M. Würtz, MM. Gräbe and Liebermann, or M. Baeyer, have effected the syntheses of alcohol, of the oil of mustard, of neurine, of alizarin, and of indigo, they have not been able to copy the natural methods of formation of these substances, the natural methods remain unknown; they have, nevertheless, been of the opinion that a great step was taken in pointing out *any method whatever* by which these bodies can be produced without the intervention of the plants and animals."—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, November 6, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. G. Brown, Sir B. V. S. Brodie, W. Briggs, M. T. Buchanan, Rev. W. H. Eley, J. Frost, T. P. Hall, H. J. Hodges, H. Jackson, F. Johnson, C. W. Low, F. M. Mercer, W. F. Pankhurst, V. E. Perez, A. Rickard, H. Smith, E. G. Smith, K. B. B. Sorabji, R. R. Steele, W. Tate, G. Thorn, P. C. Thomas, J. H. Worrall, T. Wilton, W. H. Wood.

It was announced that a ballot for the election of Fellows would take place at the next meeting (November 20th).

Dr. Japp then read a paper "*On the Action of Aldehyds and Ammonia upon Benzil*" (continued), by F. R. Japp and S. C. Hooker. In former communications relating to the joint action of aldehyds and ammonia upon compounds containing the dicarbonyl group (—CO—CO—) two general reactions have been described:—

I. $$\begin{matrix} X'—CO \\ | \\ X'—CO \end{matrix} + R'—CHO + NH_3 = \begin{matrix} X'—C—O \\ \| \\ X'—C—N \end{matrix} \diagdown\!\diagup C—R' + 2H_2O.$$

II. $$\begin{matrix} X'—CO \\ | \\ X'—CO \end{matrix} + R'—CHO + 2NH_3 = \begin{matrix} X'—C—NH \\ \| \\ X'—C—N \end{matrix} \diagdown\!\diagup C—R' + 3H_2O.$$

In addition to the above reactions a third, totally distinct reaction occurs. Thus—

$$\underbrace{C_{14}H_{10}O_2}_{\text{Benzil.}} + 2\underbrace{C_7H_6O_2}_{\text{Salicyl aldehyd.}} + 2NH_3 = \underbrace{C_{28}H_{24}N_2O_4}_{\text{New compound.}} + 2H_2O.$$

A similar reaction occurs when furfur-aldehyd is substituted for salicyl aldehyd. The present paper is devoted to an account of this new reaction, and to a study of the compound obtained with salicyl aldehyd. The authors represent this new reaction generally—

III. $$\begin{matrix} X'—CO \\ | \\ X'—CO \end{matrix} + 2R'—CHO + 2NH_3 = \begin{matrix} R'—CH—NH--CO—X' \\ | \\ R'—CH—NH—CO—X' \end{matrix} + 2H_2O.$$

Action of Salicyl Adehyd and Ammonia upon Benzil.—Equal weights of salicyl aldehyd and benzil were dissolved in alcohol with the aid of heat, and the warm solution saturated with gaseous ammonia. The new compound separated as a lemon-yellow crystalline powder. It was filtered off and extracted with boiling alcohol, and further purified by solution in boiling phenol and re-precipitation by alcohol. It was thus obtained as a white, crystalline, sandy powder, darkening when heated, fusing at 300°; almost insolubie in alcohol, ether, glacial acetic acid, &c. Analysis indicated the formula $C_{28}H_{24}N_2O_4$. This substance dissolves in boiling caustic soda, and is re-precipitated almost unchanged by hydrochloric acid; fused with caustic soda it yields benzoic and salicylic acids. When acted upon by dilute hydrochloric acid (1 to 2), at 210°, benzoic acid and the hydrochloride of a new base were formed. This base, after precipitation by ammonia, &c., was found to have the composition $C_{14}H_{16}N_2O_2$. Its platinum salt, hydrochlorate, sulphate, and picrate were prepared and examined. When fused with caustic soda this base yields salicylic acid. The authors believe the constitution of this base to be—

$$\begin{matrix} C_6H_4(OH)—CH—NH_2 \\ | \\ C_6H_4(OH)—CH—NH_2, \end{matrix}$$

and have named it dihydroxy-stilbene diamine. By the action of acetic anhydride upon the condensation product a diacetyl derivative was obtained, $C_{28}H_{22}(C_2H_3O)_2N_2O_4$, and by a further action of acetic anhydride a body with the formula $C_{22}H_{24}N_2O_6$ was formed; its reactions show it to be diacetyl-diacetoxy-stilbene diamine. It yields no benzoic acid when heated with potassium permanganate. By acting on the body $C_{22}H_{24}N_2O_6$ with caustic potash, precipitation with hydrochloric acid, &c., a substance $C_{18}H_{20}N_2O_4$ (diacetyl-dihydroxy-stilbene diamine) was obtained. By the continued action of potash all four acetyl groups were removed, and the base dihydroxy-stilbene diamine was formed. This can also be effected by heating the compound $C_{22}H_{24}N_2O_6$ with concentrated hydrochloric acid in sealed tubes. The action of benzoic anhydride upon the condensation product has also been studied: a dibenzoyl derivative, $C_{28}H_{22}(C_7H_5O)_2N_2O_4$, was obtained, which proved to be identical with the tetra-benzoyl derivative of the base. The condensation product is therefore dibenzoyl-dihydroxy-stilbene diamine. The authors have also studied the action of furfur-aldehyd and ammonia upon benzil. Two isomeric bodies, $C_{24}H_{20}N_2O_4$, were obtained.

Mr. S. U. Pickering then read a paper entitled "*Isomeric Modifications of Sodium Sulphate.*" The author has determined the heat of dissolution of sodium sulphate.

He has used the apparatus of Berthelot (*Mec. Chim.*, i., 140). He allowed a large quantity of sodium sulphate to effloresce till nearly anhydrous; various portions were then dried at different temperatures. From the author's results it is evident that there are two modifications of sodium sulphate. All the specimens not heated above 150° gave 57 cal. as the value of the equation—

$$Na_2SO_4+420H_2O.$$

Specimens heated above this temperature up to the fusing-point indicated the existence of a modification dissolving with +760 cal. The existence of the salt in two different forms may explain the discrepancies in the results arrived at by various authors.

The SECRETARY then read a paper "*On some Vanadates of the Amines*," by G. H. BAILEY. The author has prepared and carefully studied the properties of a considerable number of these compounds. His results may be summed up as follows:—That, considered alongside the vanadates of the alkali metals, the ortho-vanadates of the amines are as difficult to prepare as the corresponding potassium salts, whilst sodium ortho-vanadate crystallises readily. The meta-vanadates of the amines are much more soluble than ammonium meta-vanadate, but in their general characters and reactions they resemble the ammonium salt: the derivatives of the primary amines crystallise well, but the further introduction of alcohol radicals decreases the stability of this series of salts. The salts containing the ethyl radical seem to be at least as stable as the corresponding compounds containing methyl. The optical characters of the red vanadates show that they belong to the monosymmetric system.

The SECRETARY then read a paper entitled "*Contributions to our Knowledge of Acet-acetic Ether*" (Part I.), by J. W. JAMES. The author commenced this research with a view of obtaining some insight into the reactions of acet-acetic ether, and to establish its formula. The author first gives an account of the action of dilute acetic acid on sodium ethyl-acet-acetic ether: there seems to be no doubt that ethyl-acet-acetic ether is formed. Some mixed dialkyl-acet-acetic ethers were then prepared, with a view of ascertaining whether the order in which radicals were introduced was of importance or not. The author could not prove that allyl-methyl-acetic ether was identical with the methyl-allyl ether, on account of the difficulty of obtaining these bodies in the pure state. The methyl-ethyl derivative seemed to be the same as the ethyl-methyl body. Acetyl-acet-acetic ether was prepared, and also its copper, nickel, and cobalt derivatives. The actions of water and sodium ethylate on this body have been studied. Methyl-acetyl-acet-acetic ether and benzoyl-acet acetic ether have also been prepared and examined.

The two following papers were also read by the SECRETARY:—

"*On Magnesium Hydrosulphide Solution, and its Use in Chemico-legal Cases as a Source of Hydrogen Sulphide*," by E. DIVERS and TETSUKICHI SHIMIDZU. The authors, wishing to obtain a regular stream of pure hydrogen sulphide, found that this could be effected by gently heating a solution of magnesium hydrosulphide. Ordinary hydrogen sulphide (from ferrous sulphide and hydrochloric acid) is passed into water containing magnesia in suspension. The gas is absorbed, and the magnesia dissolves. The decanted solution is colourless, and when heated to 60° to 65° evolves a steady stream of hydrogen sulphide, free from hydrogen and hydrogen arsenide. The magnesia which is precipitated during the evolution of the gas can be re-converted by cooling and passing hydrogen sulphide.

"*On the Origin of Calcium Thiosulphate, an Emendatory Note to a Paper on the Calcium Hydrosulphides*," by E. DIVERS. After a detailed examination of the various reactions in which calcium thiosulphate is formed, the author concludes that there is essentially but one method of forming this salt, viz., the union of sulphur with calcium sulphite.

The Society then adjourned to November 20th, when a ballot for the election of Fellows will be held, and a paper "On some New Paraffins," by Khan B. B. Sorabji, will be read.

PHYSICAL SOCIETY.

November 8th, 1884.

Prof. AYRTON in the Chair.

MR. KAVARGEE was elected a member of the Society.

Prof. F. GUTHRIE read a paper on "*Certain Phenomena attending Mixture*." In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first, a mixture of water and ether is an example: When shaken up together they mix, heat is *evolved*, and a *diminution* of bulk takes place. If any excess of ether present is poured off, and the lower clear liquid *heated* in a sealed tube, it becomes turbid owing to the separation of the ether. This is accompanied by an *increase* of bulk and *absorption* of heat. Triethylamine and water and diethylamine and water are mixtures belonging to this class; the temperature of separation is a function of the ratio in which the two liquids are present. A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0° C., with *increase* of bulk and *absorption* of heat. Upon being *cooled* to about −17° C. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods were used. In the first a number of mixtures of the same two liquids in different proportions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum there might be assumed to be no "dead matter" present. In the second method, which is more delicate but more laborious, and which was used when the approximate combining proportion had been found by the first, the change of volume produced by mixture was noted; when this increment is a maximum the liquids are present in their combining proportions. These experiments gave very concordant and definite results; for example, that the molecular compound of ether and carbonic sulphide is represented by the formula $C_4H_{10}O,2CS_2$, and that of chloroform and carbonic sulphide by $CHCl_3,CS_2$. A striking confirmation of this view is afforded by the behaviour of the vapour tension of a mixture. The temperature being constant if the vapour tension be plotted with the percentages of the more volatile liquid as abscissæ, the curve is, for a mixture of two liquids which have no chemical action upon one another, as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The corresponding abscissa indicates the molecular combination found by the previous experiment.

Dr. C. R. ALDER WRIGHT read a paper by himself and Mr. C. THOMPSON on "*Voltaic and Thermo-voltaic Constants*." In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential causes an increment (*a*) in the E M.F. set up (*e*), while an increment in the strength of the other solution causes a decrement (*b*) in the E.M.F. This law is now substantiated; it is, however, found that for dilute acids instead of metallic salts *b* may be negative. The authors also find that it is possible to express

the E.M.F. of a cell by the difference of two quantities, which they term the voltaic constants. These are quantities, one relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid; it is practically defined as the E.M.F. set up when opposed to a zinc plate in a solution of the corresponding zinc salt of the same molecular strength. The authors further conclude that the E.M.F. of a given combination usually *stands in no simple relationship to the chemical action taking place in the cell*, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electrochemical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid, and being constant for that metal and liquid at a given temperature *termed thermo-voltaic constants*. This thermo-voltaic action may act with or against the chemical action in producing E.M.F. In some cases, as in that of a cell composed of iron in ferrous sulphate and cadmium in cadmic sulphate solutions, the E.M.F. is against and greater than that produced by chemical action; consequently the cell works backwards with absorption of heat.

At the close of the paper Prof. Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermo-dynamics.

NOTICES OF BOOKS.

Bulletin of the Bussey Institution. Vol. II., Part 4, (Jamaica Plain, Boston). 1884. Boston: John Allyn.

The Bussey Institution, or School of Agriculture and Horticulture, apparently in connection with the Harvard University, was established "in execution of the trusts created by the Will of Benjamin Bussey," for giving systematic instruction in agriculture, useful and ornamental gardening, and stock-raising. Owing to the great fire in Boston some years ago, and the commercial depression that followed, the revenue derived from the Bussey Trust was so greatly diminished that the whole available income had to be devoted to the maintenance of the buildings, and for instruction. Before the closing of the research laboratory and the experimental plant-house the work that had been done connected principally with agriculture is brought together in this pamphlet, the majority of the papers being by Prof. Storer. These investigations, although none of them of a purely chemical character, will afford some information to the student of agriculture, especially the rather lengthy papers on "Some Items of American Experience which suggest that Potassic Fertilisers may perhaps act in several different ways," and the "Description of an Attempt to Assay Soils by the Method of Sand Culture." In the latter investigation the plan adopted was to add small portions of the soils to be assayed to some inert material, such as siliceous sand, the young plant being watered with dilute solutions of chemical substances capable of affording food to the growing plant. The author's experiments made in this fashion "show clearly enough that while this method of assay can readily distinguish a true garden soil . . . . from the mediocre loams with which it was contrasted, it is incapable of making definite practical distinction between ordinary loams taken from fields and pastures here in Massachusetts." And the author deems the assay "incompetent to give sharp, well-defined results, as between one loam and another."

Among some other papers of minor importance we notice one of a strange character, pointing, however, to facts which may help to explain the sanitary defects occasionally met with in newly-built houses. This paper, also by Prof. Storer, is headed "Experiments on Feeding Mice with Painters' Putty, and with other mixtures of Pigments and Oil." The quantity of this delectable food that mice can consume in a given time is scarcely credible. In one experiment it was found that a mouse would eat as much as 5½ grms. of dry whiting made into putty, each day, and thrive upon it, merely for the small quantity of oil it contained—about one-fifth of the weight of the whiting. This is "as if more than 50 lbs. of dry chalk were to pass daily through a man of 150 lbs. weight." Experiments were made with putty consisting of coloured ochres, silica, and other inert materials, but the mice were found to enjoy such messes less than when whiting was used: the addition of a little of the latter, however, made the putty more agreeable to the mice. Among other substances tried were carbonates of lead and baryta. Each of these materials in the pure state proved fatal to the mice, but the addition of a small quantity of whiting served as an antidote against their poisonous action. The physiological reason for this anomaly, as the author points out, is altogether vague.

An index to this work would certainly have been an advantage; possibly, as it forms the continuation of a series of such volumes, a general index to the whole will be given; still each part, we think, might have had this valuable appendix.

CORRESPONDENCE.

SALICYLIC ACID.

To the Editor of the Chemical News.

Sir,—I have not seen any reply to the enquiry of Mr. J. H. Heywood in the Chemical News, vol. l., p. 173, as to the poisonous or non-poisonous effect of salicylic acid. Perhaps it may serve his purpose to learn that much larger doses, up to 80 grains, are successfully administered in the German medical treatment of rheumatism.—I am, &c.,

J. Crum.

Workington, Cumberland.
November 6, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 17, October 27, 1884.

Contaminated Waters and the Cholera.—M. Marey.—The author strongly advocates the theory that the propagation of cholera is mainly due to water contaminated by the excreta of cholera patients, and gives several very important facts in support of this view.

Formation of Saltpetre in Plants.—MM. Berthelot and André.—Potassium nitrate is universally present in the vegetable kingdom. It does not pre-exist in a sufficient quantity either in the manures or the soil, and must therefore be formed in the plant itself, the stem being the principal seat of its formation. This action is probably due to certain cellules which behave in the interior of the plant like the nitric ferment which, according to MM. Schlœsing and Muntz, produces saltpetre in the soil.

Oxidation of Copper.—MM. Debray and Joannis.—Copper heated with free access of air is generally transformed into cupric oxide without passing through the cuprous stage. This reaction occurs at all temperatures between 350°, and that at which the dissociation-tension

of the oxide formed reaches about the fifth part of the pressure of the atmosphere, *i.e.*, the pressure of the oxygen contained in the air. Above this temperature the black oxide formed at first is partially decomposed. About the melting-point of gold, the mixture of cupric and cuprous oxide fuses. The decomposition ceases when the decreasing tension of the oxygen, liberated from the mixture, reaches that of $\frac{1}{5}$ of an atmosphere. It is evident that the direct oxidation of copper at these high temperatures would have the same final results. Inversely, the refrigeration of the oxide, more or less decomposed, in atmospheric air effects its re-oxidation if the matter is sufficiently porous. When determining copper as cupric oxide, it is necessary not to raise it to a temperature at which it might melt, or even become agglomerated. If the copper is in large excess, as in preparing nitrogen by passing air over copper turnings heated in a tube, there is formed merely cupric oxide if the temperature is sufficiently low. If the middle of the tube is heated more strongly there is formed also cuprous oxide. When the oxygen is insufficient in quantity to saturate all the copper we never obtain an intimate mixture of the two oxides without fusion. On cooling slowly the red and the black oxides are found distinctly separated.

Rapid Preparation of Standard Solutions of Carbon Disulphide.—Ach. Livache.—The author takes a solution of soap, with which he incorporates a certain quantity of petroleum. In this he can dissolve, on stirring, more than 200 grms. disulphide of carbon per litre for 150 grms. of soap. This solution, on adding water, remains perfectly limpid, the disulphide of carbon not separating out.

Certain Reactions of Chloro-chromic Acid.—M. Quantin.—Carbon monoxide acting alone upon chloro-chromic acid transforms it into green chromium sesquichloride and violet sesquichloride. The simultaneous reaction of carbon monoxide and an excess of chlorine transforms the chromium oxychloride into sesquichloride.

Analysis of the Apatite of Logrozan.—A. Vivier.—This mineral contains 41·02 per cent of phosphoric acid combined with lime, besides 4·46 per cent of aluminium and glucinum phosphates. The calcium fluoride is 5·23 per cent.

Combination-heat of Compounds of Hydrogen and Oxygen.—A. Boillot.—Of the number of calories obtained on the combination of hydrogen and oxygen gases to form water, two-thirds are furnished by the former of these gases and one-third by the latter. The water formed does not absorb any latent heat. For 9 grms. of water formed the grm. of hydrogen liberates 23 cal., and the 8 grms. oxygen 11·5 cal. In the formation of oxygenated water each of the component gases liberates the same number of calories, *i.e.*, for 17 grms. of oxygenated water formed, the grm. of hydrogen gives 11·85 cal., and the 16 grms. of oxygen also 11·85 cal. The latent heat of this quantity of oxygenated water is 22·3 cal., of which the half comes from each of the elements. The author deduces from his investigations the density of liquid oxygen as = 0·888. M. Wroblewski found this density as intermediate between 0·89 and 0·90. M. Gérardin addresses a note on the use of hydrosulphurous acid, as a bleaching agent. In opposition to chlorine it acts by reduction, and is capable of important industrial applications.

Journal de Pharmacie et de Chemie.
Series 5, Vol. x., Aug., 1884.

Universal Presence of Nitrates in the Vegetable Kingdom.—M. Berthelot.—Already noticed.

Chemical Detection of Nitric Acid and Nitrates in Vegetable Tissues.—A. Arnaud and L. Paul.—Already noticed.

New Means of Detecting Chlorates in Solution.—M. Fourmont.—If we treat a chlorate with copper turnings and sulphuric acid, hydrochloric acid escapes and there is formed copper chloride, which tinges the solution green. Consequently, after having proved the absence of the acids which are precipitated by silver nitrate, the chlorates can be very quickly distinguished from the nitrates. In case of a mixture of chlorate and nitrate the liquid is also heated with copper turnings and sulphuric acid. The chlorate is first decomposed, hypochloric acid escapes, and the liquid turns green; then hyponitric acid follows, and the green colour is succeeded by the blue characteristic of copper. These characters are easily recognised within two minutes' time. When chlorates and chlorides are mixed, after having thrown down the chlorides with silver nitrate the chlorate is detected by means of copper turnings and sulphuric acid. When chlorides, chlorates, and nitrates exist in mixture the chlorides are first removed with silver acetate and the other acids are then detected as above by means of copper and sulphuric acid.

Volumetric Determination of Alumina in Limes and Cements.—H. Prunier.—The author takes finely powdered cement 0·428 grm., water and pure nitric acid each 2 grms. He stirs up the cement in the water in a tared flask, adds the acid, heats to render the solution as complete as possible, adds 20 grms. water, and colours the liquid with ten drops of tropeoline Oo (orangé Poirrier, No. 4). He then pours in by degrees strong ammonia until the original red colour of the mixture is reduced to a faint rose tint. The decoloration is then completed by adding by drops ammonia free from carbonate and diluted with four times its volume of water, until the solution if tested on a white plate with orange No. 4 gives a colourless mixture, or simply a pale yellow without the mixture of any reddish grey tint. All the free nitric acid is thus saturated. The alumina is then precipitated by an excess of standard alkali, say 10 or 15 c.c. of semi-normal ammonia. Water is added to make up a total weight of 50 grms. and the whole is mixed up and filtered. Two c.c. of the filtrate (=0·1712 grm. cement) are taken, coloured with 3 or 4 drops tincture of litmus, and the excess of alkali is titrated with decinormal nitric acid until it turns to the red shade of an onion skin. The volume of semi-normal ammonia (4 or 6 c.c.) contained in the 20 c.c. of the filtrate corresponding to 20 or 30 per cent of alumina, each c.c. of deci-normal acid employed would indicate 1 per cent of alumina if no iron was present. But as cements always contain more or less iron, to find the exact proportion of alumina it is necessary to deduct Fe_2O_3 from the gross sum of $Al_2O_3+Fe_2O_3$, as shown by the above alkalimetrical determination. This result is obtained by determining previously the percentage of Fe_2O_3 by means of potassium permanganate, basing upon the fact that 1 per cent of Fe_2O_3=0·642 c.c. decinormal acid.

Crystalline Colchicine.—A. Houdé.—Colchicine crystallises in prisms which turn litmus-paper slightly blue. It is very slightly soluble in water, ether, and glycerin, but dissolves in all proportions in alcohol, chloroform, and benzol.

Colchicine.—M. Zeisel.—From the *Comptes Rendus.*

Synthesis of Xanthine.—M. Armand Gautier.—Already noticed.

The Elixir of Pepsine.—P. Vigier.—A purely pharmaceutical paper.

Detection of Albuminose or Peptone in Urine.—C. Méhu.—The author makes use of an acetic solution of potassium-mercuric iodine.

Detection of Starch in Gluten Bread.—A. Mallat.—The author concludes that the only exact method is the determination of the nitrogen in a given weight of the bread by the soda-lime process.

The Composition of Cork.—Ch. Kugler.—The characteristic component of cork is suberine, a true fat, saponifiable by alkalies and oxidisable by nitric acid, which converts it into a mixture of suberic and ceric acids.

Suberine is composed of the mixed glycerides of phellonic and stearic acids.

September, 1884.

The Preparation of Hydrated Chromic Acid and on Certain Novel Properties of Chromic Anhydride.—M. H. Moissan.—The author fuses the chromic acid of commerce in a platinum capsule at a very gentle heat, when, with care, the greater part of the sulphuric acid present is volatilised. The contents of the vessel are then poured into a flat porcelain capsule. The sulphuric acid, which is much the more liquid, flows out first. The chromic acid solidifies quickly in little red rods, which are broken up rapidly, selecting such as have not been touched by the sulphuric acid and preserved in dry bottles. Chromic anhydride rapidly absorbs hydrochloric acid gas, giving off red fumes and condensing to chlorochromic acid. Hydrobromic and hydriodic acids do not, under similar circumstances, form analogous compounds.

Poisoning by Nicotine.—Dr. Rabot.—An account of a poisoning case and of the autopsy, &c.

The Falsification of Pepper by Means of Olive Kernels.—E. Landrin.—Not capable of useful abstraction.

A New Alcohol from Bird-lime.—J. Personne.—Already noticed.

October, 1884.

Purification of Methylic Alcohol.—MM. J. Regnauld and Villejean.—In the alcohol regenerated from methyl-oxalic acid the authors dissolve about 10 per cent of iodine. To this liquid they add, little by little, an aqueous solution of caustic soda in quantity sufficient to produce an entire decolouration and a distinct alkaline reaction. On being submitted to careful distillation this mixture yields methylic alcohol not convertible into iodoform, and which, if rectified over quick-lime, has the sp. gr. 0·810 at +15°.

Wood Oil of Cochin China.—J. Leon Soubeiran.—A pharmaceutical paper.

Purification of Arseniferous Zinc.—L. L'Hote.—Already inserted.

A Process for Determining the Specific Gravity of Porous Bodies.—G. Fleury.—This memoir cannot be intelligibly reproduced without the accompanying illustration.

The Kola Nut.—M. Natton.—A pharmaceutical paper.

Determination of Silver and Copper in one and the same Solution.—J. Quessaud.—The author standardises his solutions with a liquid (normal solution) containing silver and copper in known proportions, and then repeats the same operation upon an equal volume of an unknown solution. Three solutions are necessary:—(1.) A normal solution composed of 1 grm. of pure silver and 0·10 grm. of pure copper to 400 c.c. of distilled water, of which 40 c.c. are taken. The solution is made with 3 grms. pure nitric acid and 1 grm. distilled water. It is evaporated to dryness on the water-bath, and re-dissolved in distilled water. The unknown substance is dissolved in the same manner. (2.) A solution of potassium ferrocyanide at 1 per cent. (3.) A decolourising solution composed of potassium sodium tartrate, 10 grms.; soap-boiler's lye, 25 grms.; distilled water enough to make up 550 c.c. (The soap-boiler's lye is probably caustic soda lye at sp. gr. 1·310, but lyes of different strength are used in different processses for soap making.) The operation must be conducted in a neutral or faintly acid liquid, since the ferrocyanide does not precipitate copper from an alkaline solution, and the decolourising liquid is more or less neutralised according to the proportions of excess of acid. In standardising the normal solution the author takes 40 c.c. (representing 0·10 grm. of silver and 0·01 grm. of copper). The solution of ferrocyanide is run into the metallic solution drop by drop from a burette graduated into tenths of a c.c., with constant stirring until the last drop produces a faint, permanent, flesh-coloured tint. The number of degrees necessary to produce this result for 0·10 grm. silver is noted as the standard of the silver. For copper we continue to add the same solution of ferrocyanide until, by an excess of the reagent which dissolves the last traces of copper ferrocyanide, the liquid has a reddish colour after the precipitate has subsided. When this result is obtained the alkaline solution of tartrate (decolourising solution) is added drop by drop from a burette graduated into tenths of a c.c. until this red colour has disappeared, and a bluish white tint appears. We note the number of degrees of the decolourising solution necessary for transforming the copper ferrocyanide formed in a solution containing 0 01 grm. of copper. In operating upon an unknown solution 40 c.c. are taken and treated precisely as above.

Analysis of Blood which had remained for some Years in a Cavity excluded from the Air.—E. Leidié.—This paper is chiefly of physiological interest.

Second Memoir on Flour.—M. Balland.—Already noticed.

Detection of Tartaric Acid in Citric Acid.—Vulpius dissolves 0·5 grm. of the sample in question in 10 grms. of distilled water, and adds 5 drops of the solution drop by drop to 15 grms. of lime water. If the citric acid contains mere traces of tartaric acid, in a few moments there is produced a distinct turbidity, which increases on adding more of the acid solution and stirring. In this manner 1 per cent. of tartaric acid can be detected. M. Push puts 1 grm. of the sample, ground up, in a dry test-tube along with 10 grms. pure colourless sulphuric acid, and suspends the tube in a beaker containing water which is kept at a temperature close upon boiling. If the citric acid is pure the liquid takes and retains a lemon-yellow colour. But if only ½ per cent. of tartaric acid is present the mixture becomes brown in twenty-five to thirty minutes.

Moniteur Scientifique, Quesneville.
Vol. xiv., November, 1884.

Address delivered before the Chemical Section of the British Association.—Prof. H. Roscoe.—Already inserted.

Review of Foreign Researches in Organic Chemistry.—G. de Bechi.—This "review" consists of extracts from the *Berichte der Deutsch. Chem. Gesell.* and *Liebig's Annalen.*

Industrial Review and Patents.—Brief notices of patents for the manufacture of metallic nickel and cobalt, of aluminium, of solidified mineral acids, of soluble glass; for the purification of alcohol, and for improvements in the manufacture of sugar.

Patents concerning Colouring Matters.—These consist of a process for the preparation of double compounds of the azo colours with the bisulphites, and a process for the separation of the azo colours formed by the combination of the diazo derivatives of the β-naphthylamine-mono-sulphonic acids with the α-naphthol-monosulphonic acids.

Patents in the Chemical Arts taken out in France in 1884.—A classified patent list for the month of September last.

Selection of Patents obtained in France, 1884, relating to the Chemical Arts.—This list refers also to the month of September last.

The Solutions of Cupro-ammonium and their Applications.—Dr. C. R. Alder Wright, F.R.S.—From a well-known English source.

Degeneration of Yeast and the Means for making it Disappear.—J. C. Jacobsen.—Not adapted for abridgment.

Critical Study on the Analysis of Superphosphates.—N. Grignon.—In this memoir the author discusses principally the methods for the determination of reverted phosphates.

Industrial Society of Mulhouse: Session of the Chemical Committee, September 10, 1884.—The Secretary read certain letters from G. Witz, of Rouen, concerning the action of gaseous chlorine upon colouring matters or alkaloids in presence of soda. A yellow printed discharge with chromate of lead succeeded perfectly on blues and reds in seventeen seconds in chlorine previously mixed with air. White discharges required further purification. With aniline hydrochlorate the following facts were noted:—First, the instantaneous and successive production of reddish colours, turning to violet, blue, and green, more or less soluble, then blacks passing gradually through all the known phases, including an ungreenable black, and lastly a permanent orange or Bismarck brown. The whole of these changes does not require more than one or two minutes. The simple aqueous solution of aniline hydrochlorate gives absolutely distinct and different results according to its concentration, as soon as it is introduced into chlorine gas. Up to 130 grms. per litre we obtain an insoluble bright rosy chamois (which ultimately turns brown when dry); whilst with 150 grms. or upwards of the same salt there are obtained blacks with a narrow orange margin. M. Schmid has succeeded in effecting a discharge on the chrome mordant described by H. Kœchlin at the last meeting. It is merely necessary to print potassium ferricyanide and to pass the pieces into caustic soda, when the chromic oxide is converted into sodium chromate. By steaming, the same end may be gained by printing a mixture of ferricyanide and of an alkaline carbonate.

Phenic Acids of Commerce.—O. Castelhaz.—The author endeavours to distinguish "crude carbolic" acid from the varying grades of "liquid carbolic" acid, and gives processes for their commercial analysis.

The Iridium Industry.—A notice of the improvements introduced by Mr. John Holland, of Cincinnati.

Antipyrine, a New Febrifuge.—An account of another attempt to supersede quinine.

Vermilion and its Manufacture in China.—From the CHEMICAL NEWS.

A New Antiseptic, Aseptol.—E. Transer.—The scientific name of this compound is orthoxy-phenyl-sulphurous acid. It is an acid phenol, capable of neutralising ammoniacal bases. It is said to be preferable as an antiseptic to phenol, having the advantage of not being poisonous.

Certain Processes for the Analysis of Water.—A notice of a work by M. Roques, in which the method of Wanklyn, Chapman, and Smith is recommended.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3rd Série. Tome xi., August, 1884.

Manufacture of Aluminium.—Mr. James Weldon.—This memoir appeared in the *Journal of the Society of Chemical Industry* for September, 1883, and has been reproduced and commented upon in various English papers.

On Vaseline.—J. Otto.—Taken from the *Moniteur Scientifique Quesneville* for April, 1883.

Utilisation of Burnt Pyrites.—J. Creutz.—Already noticed under the *Moniteur Scientifique*, from which it is taken.

Cosmos les Mondes.
No. 5, October 9, 1884.

This number contains no chemical matter.

No. 7, October 25, 1884.

Determination of the Quantity of Organic Matter Contained in Water.—M. Limousin.—The author merely acidulates the water with a trace of sulphuric acid, heats it to 80° or 90°, and drops in a solution of permanganate until a permanent rose colouration is obtained. He adds that if the water is very highly charged with organic matter it need not be acidified, unless alkaline, or even heated!

Archives Neerlandaises des Sciences Exactes et Naturelles.
Tome xix., Part 3.

Filtration of Liquids through Fibrous Membranes.—J. C. Van Beek.—In this long and illustrated paper the author comes to the conclusion that the changes observed under the influence of presure of the duration of the experiments in the filtration of water and of matters in solution or in a very fine state of division through fibrous membranes must be ascribed to changes in the reciprocal distance of the fibres constituting the membrane.

MEETINGS FOR THE WEEK

THURSDAY, Nov. 20th.—Chemical, 8.—Ballot for the election of Fellows.—"On Some New Paraffins," by Khan Bahadur Dr. Bomanji Sorabji. "On Additive and Condensation Compounds of Di-ketones with Ketones," by Dr. F. R. Japp and Dr. N. H. Miller. "On a New Method of Determining the Vapour Pressure of Solids and Liquids," by Dr. W. Ramsay and Sydney Young. "Action of Haiogens on the Salts of Trimethyl-sulphine," by Dr. L. Dobbin and Orme Masson, M.A., D.Sc. "Note on the Sulphates of Potassium and Lithium," by Spencer U. Pickering. "Researches on the Application of Iron Sulphate in Agriculture," by A. B. Griffiths.

SATURDAY, 22nd.—Physical, 3. "Note on a Point in the Theory of Pendent Drops," and "On a Capillary Multiplier," by A. M. Worthington.

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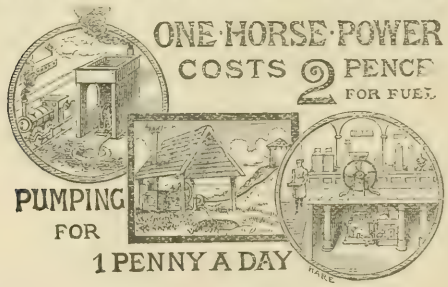

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ON THE

TEACHING OF NATURAL SCIENCE AS A PART OF THE ORDINARY SCHOOL COURSE,

AND ON THE

METHOD OF TEACHING CHEMISTRY IN THE INTRODUCTORY COURSE IN SCIENCE CLASSES, SCHOOLS, AND COLLEGES.*

By HENRY E. ARMSTRONG, Ph.D., F.R.S., Sec.C.S., Professor of Chemistry in the Finsbury Technical College.

However fully it may be admitted by the few that it is important, nay essential, that all members of the community, whatever their station or occupation, should during their school career receive some instruction in the elements of Natural Science, the general public have not as yet had brought home to them with sufficient clearness that just as a knowledge of foreign language is essential to all who are brought into intercourse with foreigners, so in like manner is a correct knowledge of the elements of natural science of direct practical value to all in their daily intercourse with Nature, apart from the pleasure which such knowledge affords. In fact, judged from a purely utilitarian standpoint, the advantages to be derived from even the most elementary acquaintance with what may be termed the science of daily life are so manifold that if once understood by the public, the claims of science to a place in the ordinary school course must meet with universal recognition. To quote Huxley†: "Knowledge of Nature is the guide of practical conduct . . . any one who tries to live upon the face of this earth without attention to the laws of Nature will live there for but a very short time, most of which will be passed in exceeding discomfort: a peculiarity of natural laws, as distinguished from those of human enactment, being that they take effect without summons or prosecution. In fact, nobody could live for half a day unless he attended to some of the laws of nature; and thousands of us are dying daily, or living miserably, because men have not yet been sufficiently zealous to learn the code of Nature."

But it is also and mainly on other and far higher grounds that we should advocate universal practical teaching of the elements of natural, and more particularly of so-called physical, science: viz., that it tends to develop a side of the human intellect which, I believe, I am justified in saying is left uncultivated even after the most careful mathematical and literary training: the faculty of observing and of reasoning from observation and experiment. It is entirely from this latter point of view that I shall venture to propound a scheme for teaching the elements of that branch of physical science with which I am most intimately acquainted.

This Exhibition affords some few noteworthy illustrations of the way in which the importance of teaching the elements of natural science has received practical recognition in our schools. Thus we have indications of the work being done by the Birmingham School Board; the London School Board call attention to their system of training pupil-teachers in science; Mr. Robins shows plans of one of the best, if not the best, equipped school chemical laboratory—that of the Manchester Grammar School. Also, it is well known that at many of the larger schools, such as Clifton College, Eton, Harrow, Rugby, St. Paul's, Giggleswick, and the North London Collegiate School for Girls, ample provision is made for teaching one or more branches of natural science; and not a few other examples might be quoted. But in how large a proportion of the schools throughout the country is such training neglected? and there is much cause for complaint in the fact that in those schools in which science is taught, it is after all in most cases but a kind of "refuge for the destitute," only those who have failed on the classical side and those judged to be inferior in intellect being turned over to the so-called modern side. This is probably due to a variety of causes: to the ignorance already referred to of the public of the importance and value of such training, or it would be demanded of the schools; to the ignorance of even the barest elements of science of the majority of teachers in charge of schools; to the want of good science teachers and of suitable books; to the supposed expense of teaching science; and lastly—and I believe this to be the most important of all the causes which operate against the teaching of science—to the imperfection of our method of teaching; there can be little doubt, in fact, that the majority of teachers of the generally recognised subjects who have themselves no scientific knowledge see clearly enough that very little good comes of teaching science in the manner in which it is commonly taught in schools.

The great objection to the method at present in vogue appears to me to be that it is practically the same whether science is taught as a part of the general school course, or whether it is taught professionally: in other words, a lad studies chemistry, for example, at school in just the same way as at a science college, the only difference being that he does not carry his studies so far at school as at college. This, I believe, is the primary fault in our present system. In my opinion, no single branch of natural science should be selected to be taught as part of the ordinary school course, but the instruction should comprise the elements of what I have already spoken of as the science of daily life, and should include astronomy, botany, chemistry, geology, mechanics, physics, physiology, and zoology—the olla podrida comprehended by Huxley under physiography, but which is perhaps more happily expressed in the German word *Naturkunde*—in so far as is essential to the understanding of the ordinary operations and objects of Nature, the teaching from beginning to end being of as practical a character as possible, and of such a kind as to cultivate the intelligence and develop the faculties of observing, comparing, and reasoning from observation; and the more technical the course the better. The order in which these subjects should be introduced is matter for discussion; personally, I should prefer to begin with botany, and to introduce as soon as possible the various branches of science in no particular order, but that best suited to the understanding of the various objects or phenomena to which the teaching for the time being had reference. The extent to which instruction of this kind is given must entirely depend on the class of scholars.

There are few teachers capable of giving such instruction, and fewer books of a character suited to ordinary requirements. The development of such a system will, in fact, require the earnest co-operation of a number of specialists; but apart from the difficulty of securing efficient co-operation, there is no reason why some such scheme should not be elaborated at no distant date. If action is to be taken, however, there must be no delay, or the opportunity will be lost. I trust that this meeting will be prepared to give much attention to this question, and that it may be possible to continue the discussion on other platforms, as it is fundamentally important and deserving of the most serious consideration of educationalists. No doubt it will be said that the object of introducing the teaching of science into the school course is to afford mental training of a particular character, not the inculcation of useful knowledge, and that this end can

* International Health Exhibition, London, 1884. Conference on Tuesday, August 5, 1884.

† This writer's "Introductory" to Macmillan's Science Primers, and his "Physiography: an Introduction to the Study of Nature," should be studied by all who wish to know what science is and how it should be taught.

be secured by teaching well some one branch of science. Admitting that this has been the case, however, there is no reason why it should be in the future: if while developing the intellect it be possible—and it certainly is—to impart much valuable information; and if—as it certainly is—the teaching be rendered easier and more attractive because it has direct reference to the familiar objects and operations of Nature. We cannot, indeed, any longer afford to grow up ignorant of all that is going on around us, and without learning to use our eyes and our reasoning powers; we cannot afford to be unacquainted with the fundamental laws of health; but we must ever remember "that knowledge of Nature is the guide of practical conduct," and no effort must be spared to render our system of education an effectual preparation and truly adapted to the exigencies of practical life. The female educators appear already to have grasped the importance of such teaching, and under the guise of domestic economy much that I advocate is being taught in girls' schools; it is to be hoped that ere long something akin to the domestic economy course in girls' schools will find a place in boys' schools.

To pass now to the consideration of the mode of teaching my own special subject in science classes, such as those held under the auspices of the Science and Art Department, and in the introductory course for students in science schools and colleges generally. To deal first with the former. Inspection of the syllabus for the elementary stage, together with the study of the examination papers of the past few years, will show that the student is mainly required to have an elementary knowledge of the methods of preparing, and of the properties of the commoner *non-metallic* elements and their chief compounds. There is thus practically no distinction to be drawn between the knowledge required of students under the Science and Art Department, and of those who are making the study of chemistry the business of their lives. But surely it is not the function of the Science and Art Department to train up chemists, and I am satisfied that it is neither their desire nor their intention to do so; their object undoubtedly is to encourage the teaching of chemistry as a means of cultivating certain faculties, and in order that the fundamental laws of chemistry may be understood and their commoner applications realised. It is not difficult to understand how the system has grown up and why it is maintained; I do not believe it is because the Department consider it a satisfactory one; but they know full well that a better system is not yet developed and that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers. With all deference, however, I venture to add that the programme has been drawn up too much from the point of view of the specialist, and that too little attention has been devoted to it from the point of view of the educationalist. The course I am inclined to advocate would be of a more directly useful character. There is no reason why in the beginning attention should be confined to the non-metals, especially when certain of the metals enter so largely into daily use; and provided that it involve no sacrifice of the opportunities of developing the faculties which it is our special object to cultivate by the study of chemistry, there is no reason against, but every reason for, selecting subjects of every day importance rather than such as are altogether outside our ordinary experience, such, for example, as the oxides of nitrogen: even chlorine, except in relation to common salt, might be omitted from special study. The presumed distinction between so-called inorganic and organic chemistry should be altogether put aside and forgotten, and the elements of the chemistry of the carbon compounds introduced at a very early stage in order that the phenomena of animal and plant life might come under consideration. To give the barest possible outline of a programme, I would include such subjects as the following in the syllabus:—

The chemistry of air, of water, and of combustion. The distinction between elements and compounds. The fundamental laws which regulate the formation of compounds and the chemical action of bodies upon one another (*i.e.*, the nature of so-called chemical change). The chemical properties of the metals in ordinary use, with special reference to their uses and the action upon them of air, water, &c. The composition of natural waters. The distinction between fats, carbohydrates, and albuminous substances in so far as is essential to the understanding of the relative values of different foods and respiration and growth in animals and plants (outlines of the chemistry of animal and plant life, in fact); the nature of the processes of fermentation, putrefaction, and decay.

The instruction in these subjects should in all cases be imparted by means of object-lessons and tutorial classes; lectures pure and simple should, as far as possible, be avoided. The students should by themselves go through a number of practical exercises on the various subjects. I would abolish the teaching of tables for the detection of simple salts, the teaching of analysis, as at present conducted, being, I believe, in most cases, of very little if any use except as enabling teachers to earn grants.

In schools and colleges in which chemistry is taught as a science, and ostensibly with the object of training young people to be chemists, it is the almost invariable practice that the student first devotes more or less time to the preparation of the commoner gases, and then proceeds to study qualitative analysis; quantitative determinations are made only during the later period of the course. I believe that the system has two great faults: it is too mechanical, and does not sufficiently develop the faculty of reasoning from observation; and actual practice in measurement is introduced far too late in the course. It is of great importance that the meaning of the terms equivalent, atomic weight, molecular weight, should be thoroughly grasped at an early stage, but according to my experience this is very rarely the case; there is no such difficulty, however, if the beginner is taught to make a few determinations himself of equivalents, &c., as he very well may be. It is not necessary here to enter into a more detailed criticism, but I propose instead to give a brief description of a modification of the existing system which in my hands, in the course of about four years' experience, has furnished most encouraging results, and which I venture to think is worthy of an extended trial.

Instead of merely preparing a variety of gases, the student is required to solve a number of problems experimentally: to determine, for example, the composition of air and of water; and the idea of measurement is introduced from the very beginning, as the determination is made quantitatively as well as qualitatively. Each student receives a paper of instructions—two of which are printed as an appendix to this paper—which are advisedly made as bare as possible so as to lead him to find out for himself, or enquire, how to set to work; and he is particularly directed that, having made an experiment, he is to enter in his notebook an account of what he has done and of the result, and that he is then and there to ask himself what bearing the result has upon the particular problem under consideration, and having done so, he is to write down his conclusion. He is thus at once led to consider what each experiment teaches; in other words, to reason from observation. Apart from the mental exercise which this system affords, if the writing out of the notes be properly supervised, the literary exercise which it also affords is of no mean value.

In illustration, I may here very briefly describe the manner of working out the second problem in the course. The problem being: To determine the composition of water, the student receives the instruction: 1. Pass steam over red-hot iron brads, collect the escaping gas, and apply a light to it. (N.B. The gas thus produced is called hydrogen). He is provided with a very simple apparatus, consisting of a small glass flask containing water, joined by a narrow bent glass tube to an iron tube (about 9

inches long and ½ to ¾ inch wide) in which the brads are placed, a long glass tube suitably bent for the delivery of the gas being attached to the other end of the iron tube. Plaster-of-Paris is used instead of corks to make the connections with the iron tube. The iron tube is supported over a burner, and heated to redness; the water in the flask is then heated to boiling, and the steam thus generated is passed over the brads; the escaping gas is collected over water in the usual manner. Having made this experiment, and observed that on passing steam over red-hot iron the gas hydrogen is produced, the student proceeds to consider the bearing of this observation. The hydrogen must obviously be derived either from the water or from the iron, if not from both. Those who already know that iron is iron, so to speak, at once infer that the hydrogen is derived from the water: it is, however, pointed out that even if it be known that iron is a simple substance, this observation taken alone does not prove that hydrogen is contained in water.

2. The student next learns to prepare hydrogen by the ordinary method of dissolving zinc in diluted sulphuric acid, and makes a few simple experiments whereby he becomes acquainted with the chief properties of the gas.

3. Having done this, he is instructed "to burn dry hydrogen at a glass jet underneath a cold surface and to collect and examine the product." The product is easily recognised as water, and the immediate answer to the question, "What does this observation teach?" is, that since iron is absent, taken in conjunction with experiment 1, the production of water on burning hydrogen in air, the composition of which has already been determined, is an absolute demonstration that hydrogen is contained in water.

4. Having previously studied the combustion of copper, iron, and phosphorus in air, and having learnt that when these substances burn they enter into combination with the oxygen in air, the student is also led to infer from the observation that hydrogen burns in air producing water, that most probably it combines with the oxygen, and that water contains oxygen besides hydrogen. It may be, however, it is then pointed out, that the hydrogen, unlike the phosphorus, &c., combines with the nitrogen instead of with the hydrogen, or perhaps with both. He is, therefore, instructed to pass oxygen over heated copper, weighing the tube before and after the operation, and subsequently to heat the "oxide of copper" in a current of hydrogen. He then observes that water is formed, the oxygen being removed from the copper: and since nitrogen is absent, it follows that water consists of hydrogen and oxygen, and of these alone.

5. By repeating this experiment so as to ascertain the loss in weight of the copper oxide tube and the weight of water produced, the data are obtained for calculating the proportions in which hydrogen and oxygen are associated in water.

In practice, the only serious difficulty met with has been to induce students to give themselves the trouble to consider what information is gained from a particular observation; to be properly inquisitive, in fact. I cannot think that this arises, as a rule, from mental incapacity. When we consider how the child is always putting questions, and that nothing is more beautifully characteristic of young children than the desire to know the why and wherefore of everything they see, I fear there can be little doubt that it is one of the main results—and it is indeed a lamentable result—of our present school system that the natural spirit of enquiry, inherent to a greater or less extent in every member of the community, should be thus stunted in its growth, instead of being carefully developed and properly directed.

Having in the manner which I have described studied air, water, the gas given off on heating common salt with sulphuric acid, and the ordinary phenomena of combustion, the student next receives a paper with directions for the comparative study of lead and silver (see Appendix). The experiments are chosen so as to afford an insight into the principles of the methods ordinarily employed in qualitative and quantitative analyses, and the student who has conscientiously performed all the exercises is in a position to specialise his studies in whatever direction may be desirable.

The system I have thus advocated undoubtedly involves far more trouble to the teacher than that ordinarily followed, but the student learns far more under it, and I assert with confidence that the training is of a far higher order, and also of a more directly useful character. I believe it to be generally applicable, and that it would be of special advantage in those cases in which only a short time can be devoted to the study of chemistry, as in evening classes and medical schools. At present the only practical teaching vouchsafed to the majority of students in our large medical schools is a short summer course, during which they are taught the use of certain analytical tables: as a mental exercise, the training they receive is of doubtful value; the knowledge gained is of little use in after life, and the course certainly ought not to be dignified by being spoken of as a course of Practical Chemistry: *test-tubing* is the proper appellation. It is not a little remarkable also that even the London University Syllabus nowhere specifies that a knowledge even of the elements of quantitative analysis will be required of candidates either at the Preliminary Scientific or First M.B. Examination, and this too when, as is well known, an analysis to be of any practical value must almost invariably be quantitative. It is little less than a disgrace to the medical profession that a subject of such vital importance as chemistry should be so neglected.

If, however, we are to make any change in our method of teaching Science; if we are to teach Science usefully throughout the country, two things are necessary:—Teachers of Science must take counsel together, and the Examining Boards must seriously consider their position. There can be little doubt that in too many cases the examinations are suited to professional instead of to educational requirements: and that the professional examinations are often of too general a character, and do not sufficiently take into account special requirements.

Appendix.

Problem: to Determine the Composition of Air.

N.B.—Immediately after performing each experiment indicated in this and subsequent papers, write down a careful description of the manner in which the experiment has been done, of your observations and the result or results obtained, and of the bearing of your observations and the result or results obtained on the problem which you are engaged in solving. Be especially on your guard against drawing conclusions which are not justified by the result of the experiment; but, on the other hand, endeavour to extract as much information as possible from the experiment.

1. Burn a piece of *dry* phosphorus in a confined volume of air, *i.e.*, in a stout Florence flask closed by a caoutchouc stopper. Afterwards withdraw the stopper under water, again insert it when water ceases to enter, and measure the amount of water sucked in. Afterwards determine the capacity of the flask by filling it with water and measuring this water.

N.B.—The first part of the experiment requires care, and must be done under direction.

2. Allow a stick of phosphorus lashed to a piece of stout wire to remain for some hours in contact with a known volume of air confined over water in a graduated cylinder. After noting the volume of the residual gas, introduce a burning taper or wooden splinter into it.

N.B.—The residual gas is called *nitrogen*.

3. Burn a piece of dry phosphorus in a current of air in a tube loosely packed with asbestos. Weigh the tube, &c., before and after the experiment.

4. Repeat Experiment 2 with iron-borings moistened

with ammonium chloride solution. Preserve the residual gas.

5. Suspend a magnet from one arm of a balance; having dipped it into finely divided iron, place weights in the opposite pan, and, when the balance is in equilibrium, set fire to the iron.

6. Pass a current of dry air through a moderately heated tube containing copper. Weigh the tube before and after the experiment; also note the alteration in the appearance of the copper.

7. Strongly heat in a *dry* test-tube the red substance obtained by heating mercury in contact with air. At intervals plunge a glowing splinter of wood into the tube. Afterwards note the appearance of the sides of the tube. (Before performing this experiment ask for directions.)

N.B.—The gas obtained in this experiment is named *oxygen*.

8. Heat a mixture of manganese dioxide and potassium chlorate in a dry test-tube, and at intervals plunge a glowing splinter into the tube. This experiment is to acquaint you with an easy method of preparing oxygen in quantity.

9. Prepare oxygen as in Experiment 8, and add it to the nitrogen from Experiment 4 in sufficient quantity to make up the bulk to that of the air taken for the latter experiment. Test the mixture with a burning taper or splinter.

10. Dissolve copper in nitric acid and collect the escaping gas (nitric oxide); add some of it to oxygen and some of it to air.

11. Fill a large flask, provided with a well-fitting caoutchouc stopper and delivery tube, with ordinary tap water, and gradually heat the water to the boiling-point; collect the gas which is given off in a small cylinder, and add nitric oxide to it. Also collect a sufficient quantity in a narrow graduated cylinder, and treat it as in Experiment 2.

Comparative Study of Silrer and Lead.

Silver.—Symbol, Ag. (Argentum). Atomic weight, 107·67. Specific heat, 0·05701.

Lead.—Symbol, Pb. (Plumbum). Atomic weight, 206·47. Specific heat, 0·03140.

1. Determine the relative density of lead and silver at a known temperature by weighing in air and in water.

2. Separately heat known weights of lead and silver for some time in the air, allow to cool, and weigh.

3. Separately convert known weights of lead and silver into nitrates, and weigh the latter. From the data thus obtained calculate the *equivalents* of lead and silver.

4. Convert the known weights of nitrates thus obtained into chlorides, and weigh the latter.

5. Compare the action on lead and silver of chlorhydric acid; of dilute and concentrated sulphuric acid, using the acid both cold and hot; and of cold and hot nitric acid.

6. Using solutions of the nitrates, compare their behaviour with chlorhydric and sulphuric acids, hydrogen sulphide, potassium iodide, and potassium chromate. Ascertain the behaviour of the precipitate formed by chlorhydric acid when boiled with water, and when treated with ammonia solution.

7. Compare the behaviour of lead and silver compounds on charcoal before the blowpipe.

8. Tabulate the results of your experiments with lead and silver in parallel columns.

9. Ascertain whether the substances given you contain lead or silver.

10. Determine silver in an alloy of lead and silver by cupellation.

11. Study the method of determining silver volumetrically by means of a *standard solution* of ammonium thiocyanate. Determine the percentage of silver in English silver coinage.

12. Determine silver as chloride by precipitation.

13. Dissolve a known weight of lead in nitric acid, precipitate it as sulphate, collect and weigh the latter.

14. What are the chief ores of lead and silver? How are lead and silver extracted from their ores? How is silver separated from lead? How is it separated from burnt Spanish pyrites? What are the chief properties and uses of lead and of silver? State the composition of the chief alloys of lead and silver.

A NEW REACTION FOR THE ALBUMENOIDS AND THEIR NITROGENOUS AND SULPHURETTED DERIVATIVES.

By W. MICHAILOW.

The substance in question is added to a solution of ferrous sulphate, treated with sulphuric acid (undiluted), and then cautiously mixed with a very small quantity of nitric acid. If nitrogen and sulphur are present there appear, along with the well-known brown rings, also rings of a blood-red colour, formed apparently at the expense of the nascent ferric oxide and of the hydrosulphocyanic acid formed simultaneously from the albumenoids of the action of the sulphuric acid. The appearance of a faint rose colour must be disregarded, as it is produced on merely mixing the reagents without any albumenoid body.—*Journal Russ. Phys. Chem. Gesellschaft.*

THE PERIODIC LAW AND THE OCCURRENCE OF THE ELEMENTS IN NATURE.

By T. CARNELLY.

The theory concerning the occurrenee of the elements in nature is based upon the periodic law. Hence it is necessary to keep in view three facts which have been mentioned by Mendeleeff in his original communication on the periodic law (*Annal. Chem. Pharm. Suppl.*, 8.)

a. That although all elements belonging to the same group evince close relations to each other, yet the elements of the even series are more closely connected with each other than with those of the odd series, and in like manner the elements pertaining to the odd series are far nearer to each other than to those of the even series.

b. In the elements of the second series from carbon to fluorine, and in the third from sodium to silicon, the rule *a* is often inverted. This appears evident when considering Lothar Meyer's "curve of the elements" (see "Modern Chemical Theories") which, as soon as it has reached carbon, rises until it meets sodium, instead of descending regularly, and then falls from sodium to silicon, instead of rising. The inverted character of the curve represents accurately many properties of the elements which lie within the limits above mentioned.

c. The elements belonging to the eighth group are in many respects peculiar. Without doubt they form links between the even series on the one hand and the odd series on the other,—a fact which is rendered manifest by Lothar Meyer's curve, according to which it appears quite evident that it forms a gradual transition from the even to the odd series, or rather from the descending to the ascending parts of the curve. The elements of this group are always to be found at the minimum points of the curve.

After the above necessary explanations the author proceeds to the immediate object of the communication, which he divides into three parts, that is to say:—

1. *Reducibility of the Elements.*—Elements which belong to odd series are, as a rule, readily brought into the free

condition. On the other hand, those elements belonging to the even series are only set free with difficulty.

The only exceptions to this rule are carbon, nitrogen, oxygen, sodium, magnesium, and silicon, which find an explanation in *b*, and likewise the elements of group VIII. (compare rule *c*.)

2. *Occurrence of the Elements in Nature in a Free State.*—This point, indeed, is closely connected with the reducibility already considered.

Elements belonging to the even series, with the exception of carbon, nitrogen, oxygen, and the group VIII., *never* occur in nature in a free condition. The elements belonging to odd series are frequently met with in this condition.

Thus we often find the following members of the uneven series in the free condition:—Copper, silver, gold, mercury, arsenic, antimony, bismuth, sulphur, selenium, tellurium; lead and tin occasionally occur in the free state in nature. Gallium, indium, thallium, and cadmium are so sparingly distributed that we can scarcely determine whether they occur in the free condition or not.

Among the elements which belong to uneven series and are yet not met with free, the only noteworthy exceptions are chlorine, bromine, iodine, fluorine, zinc, and phosphorus, whilst sodium, magnesium, aluminium, and silicon are explained by rule *b*. As for the exceptions among the even series, carbon, nitrogen, and oxygen, rank under *b*, and the elements of group VIII. under *c*.

3. *Occurrence of the Elements in Nature in a Combined Condition.*—Here the elements chlorine, bromine, iodine, fluorine, and the group VIII., must be reserved for future consideration.

The elements belonging to the odd series occur in nature ordinarily as sulphides or double sulphides (or selenides, tellurides, or arsenides), *i.e.*, in combination with a negative element belonging to an odd series, in rare instances only as oxides. Elements belonging to the even series are commonly found as oxides or double oxides (with formation of silicates, carbonates, sulphates, aluminates, &c.), that is to say in combination with a negative element belonging to an *even* series, and never (with two exceptions) as sulphides.

Thus elements of the even series are met with as oxides or double oxides:—

Commonly: lithium (in lepidolite, &c.), potassium (in saltpetre, felspar, &c.), rubidium, cæsium, beryllium, calcium, strontium, barium, boron, scandium, yttrium, lanthanum, ytterbium, carbon, titanium, zirconium, cerium, thorium, vanadium, niobium, didymium, tantalum, oxygen, chromium, tungsten, manganese.

Frequently: nitrogen (in saltpetre), molybdenum.

Seldom or never: none.

As sulphides:—

Commonly: molybdenum.

Very rarely, manganese (also oxygen as sulphurous acid in volcanic gases.

Elements belonging to the uneven series occur:—

As sulphides, selenides, and tellurides.

Commonly: copper, silver, zinc, cadmium, mercury, gallium, indium, thallium, lead, antimony, sulphur, selenium, tellurium.

Frequently: arsenic, bismuth, tin.

Never: gold, sodium, magnesium, aluminium, silicon, phosphorus (see rule *b*.)

As oxides:—

Commonly: sodium, magnesium, aluminium, silicon, phosphorus (see *b*), and tin.

Frequeutly: zinc and copper.

Rarely: lead, antimony, bismuth, and arsenic.

Group VIII. The elements of this group, save iron, cobalt, and nickel, never occur in combination. Hence we need merely take into consideration the first three elements of this group.

Iron occurs mostly as oxide, but frequently as sulphide, Cobalt occurs mostly as sulphide, but often as oxide. Nickel is almost always met with as sulphide and arsenide, and very rarely as oxide.

Iron, the first member of the triad, much resembles the elements of the even series, whilst nickel, the last member, approaches closely to the elements of the odd series. This shows in a very striking manner that in the group VIII. we have a gradual transition from the even to the odd series.

The halogens, chlorine, bromine, iodine, fluorine, the most electro-negative elements, occur in nature in combination with the most electro-positive metals, as chlorides, bromides, iodides and fluorides, and (if we omit certain metallic oxy-chlorides and sulpho-chlorides) in combination with oxygen or sulphur.

The above-mentioned facts may be thus expressed with reference to Lothar Meyer's curve of the elements.

Elements whose place is on falling parts of the curve are difficult to reduce, and never occur in nature in a free condition, or in combination as sulphides, but always in combination with oxygen as oxides or double oxides (silicates, sulphates, carbonates, &c.); whilst the elements whose place is on ascending parts of the curve are easily reduced, and occur almost always—more or less—in a free condition, and also in combination with sulphur, and very rarely with oxygen.—*Berichte der Deutsch. Chemischen Gesellschaft.*

ON THE DIAMOND-BEARING ROCKS OF SOUTH AFRICA.*

By Professor H. E. ROSCOE, LL.D., F.R.S., &c.

The communication opens with an account of the general features of the diamond-bearing region, based chiefly on the papers of Mr. Dunn and Mr. W. H. Huddleston, with special reference to the theory of the volcanic origin of the "pipes" in which the diamonds occur, first advanced by Prof. E. Cohen, of Strasburg.

The strata at Kimberley Mine (from which the specimens referred to in this paper were kindly sent by Mr. Loewenthal) are then described; two shafts which have been sunk there—one in the "pipe," the other in the shale near it—passed through the following strata:—

(1) "*Pipe.*"

Red sand	3 ft.
Tufaceous limestone	15 ,,
Soft yellow earthy diamond rock	30 ,,
Soft blue diamond rock, proved to	282 ,,
Total excavated	330 ,,

(2) "*Outside the Pipe.*"

Red sand	3 ft.
Tufaceous limestone	5 ,,
Yellow shale	20 ,,
Black carbonaceous shale	10 ,,
Two thin bands of black dust in shale	1 ,,
Black shale	236 ,,
Dolerite	2 ,,
Total excavated	277 ,,

The diamonds are found in the yellow and blue "stuff" along with garnets, mica, bronzite, ilmenite, pyrite, &c., and are separated by washing the broken-up earth in sluices similar to those used in gold mining. The annual value of the diamonds from Kimberley is said to be £3,750,000, and the total amount raised since 1870 to reach the enormous sum of £40,000,000.

The specimens forwarded were as follows:—

* A Paper read before the Manchester Literary and Philosophical Society, October 21, 1884.

I. A compact greenish-grey rock, labelled "The Hard Rock."

II. A compact rock of dull rusty brown colour, labelled "Layer of Ironstone."

III. A friable earthy rock of greenish-blue colour in which the diamonds occur.

IV. A mixture of several minerals, in pieces about the size of a pea, labelled "Coarse heavy Deposit, Kimberley blue ground."

V. A similar mixture, in much finer grains, labelled "Fine heavy Deposit, Kimberley blue ground."

Sections of the first three specimens were cut and sent to Professor Bonney, F.R.S. An abstract of his report upon them is as follows:—

I. This rock is an actinolitic diabase, and could not be distinguished from specimens obtained from various British localities, where rocks of paleozoic or greater age occur.

II. This is rather a decomposed basalt belonging to the same group as I., but probably from a different mass and altered in a different way.

These two specimens were analysed with the following results:—

	I.	II.	
SiO_2	58·03	48·47	
Al_2O_3....	15·53	16·33	
Fe_2O_3 ..	—	9·85	
FeO	9·64	1·65	
MnO	4·54	0·48	
CaO	6·99	8·43	
MgO	4·55	7·38	
Loss on ignition....	—	7·44	{5·55% at 120° / 1·89 at red heat

It will be observed that these have a very similar composition, the second differing from the first in containing a considerable percentage of water, and in the fact that its iron is almost entirely in the peroxidised condition.

III. Of this specimen, the diamond-rock itself, Prof. Bonney reports as follows:—

"No. III. is evidently a breccia composed of a compact serpentinous rock, of dark colour; the fragments and the paste in which they are embedded apparently being similar in character; one or two scales of bronzite and a black mica are scattered in the matrix with some small grains of a black mineral of irregular fracture, and one of a brown mineral. Microscopic examination does not enable me to come to a definite conclusion as to the nature of this earth. So far as I can make out, the ground mass consists of a very minute aggregation of doubly refracting crystallites of no very definite but rather fibrous shape, and specks of ferrite. Here and there (and these patches have rather definite outlines and an approach to crystal form) the colouring mineral is opacite. Frequent cracks appear to traverse the slide, occupied by a clearer mineral similar to that disseminated through the slide. There is a small crystal resembling a hydrous bronzite. I cannot recall ever having seen a slide exactly of this character, but I have several that throw some light upon it, and I have a very strong suspicion that the fragments have been a basalt-glass or an olivine-glass, more probably the latter, converted by hydration into a kind of serpentine. As a rule the peridotites appear to be deep-seated rocks, but it is quite possible that there may be occasional exceptions. I do not see anything specially characteristic of a breccia of volcanic origin, but there is nothing incompatible with this."

An analysis of the earth gave the following numbers:—

SiO_2	46·16	
Al_2O_3..	10·00	
FeO	6·71	
MnO	0·34	
CaO	3·84	
MgO	16·63	
Loss on ignition..	15·43	{9·75 at 120° / 5·68 at red heat

It was noticed that a peculiar smell, somewhat like that of camphor, was evolved on treating the soft blue diamond-earth with hot water, and an attempt was made to isolate the aromatic body. A quantity of the earth was powdered and digested with ether. On filtering and allowing the ether to evaporate, a small quantity of a crystalline, strongly aromatic body was obtained. The substance was very volatile, burned easily with a smoky flame, and melted at about 50° C.

The presence of this carbonaceous substance in the diamond matrix is most interesting, and tends to confirm Professor Cohen and Mr. Dunn's hypothesis that the carboniferous shales that are penetrated by the diamond-bearing "pipes" have been the source of the carbon which is now found in the crystalline form as diamond. It is unfortunate that the quantity of the substance obtained was too small to admit of a full investigation of its composition and properties.

The results of the examination of the remaining specimens, which are samples of the deposit obtained by washing the "stuff" at Kimberley, are interesting, as showing the minerals which accompany the diamond in the matrix:—

100 grms. of the "fine heavy deposit" contained—

	Grms.
Garnet	10·76
Bronzite	3·64
Ilmenite	54·80
Pyrites	0·14
Mica	0·20
Limonite	16·12
Pieces of the rock which have escaped disintegration with some limonite ..	10·84
Coarse sand—a mixture of all the above..	3·46
	99·96

The composition of the limonite and bronzite are given below:—

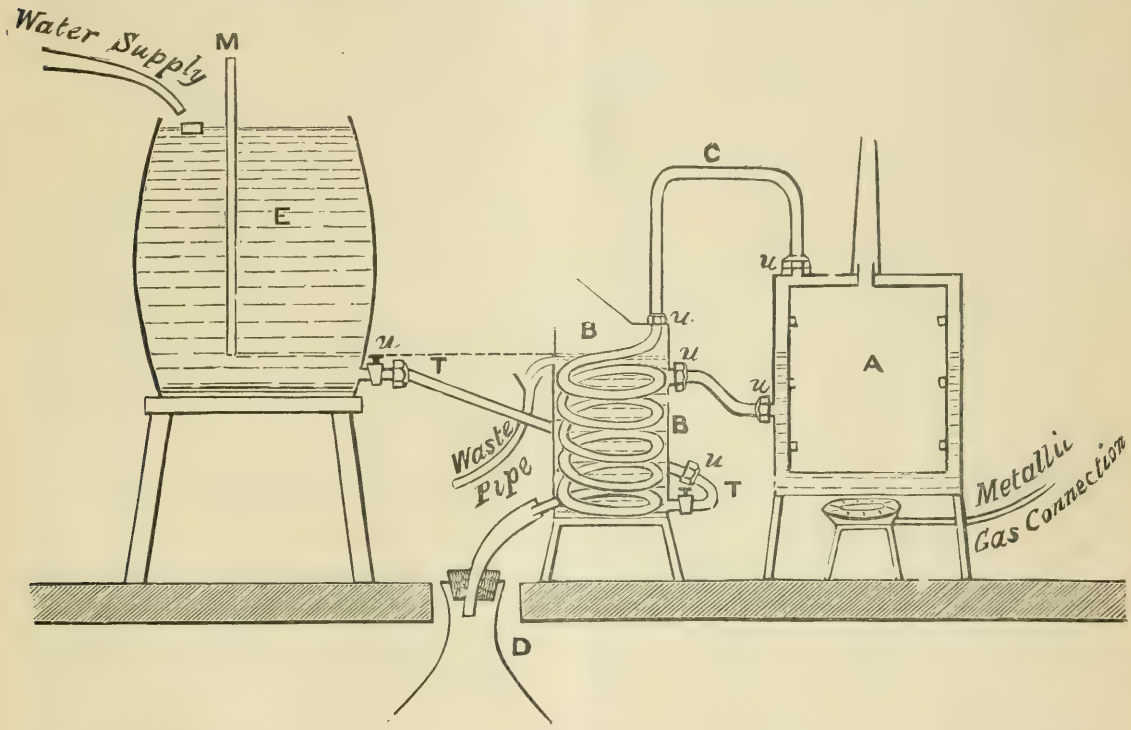
	Limonite.	Bronzite,
SiO_2 per cent	6·93	55·17
Al_2O_3 ,, ...	6·85	2·95
Fe_2O_3 ,, ...	71·40	—
FeO ,, ...	—	5·76
CaO ,, ...	0·71	3·64
MgO ,, ...	0·86	32·83
H_2O ,, ...	12·53	—
	99·28	100·35

A CONSTANT LEVEL STEAM-OVEN AND STILL.

By ALEX. J. ATKINSON.

The accompanying sketch of a combined steam-oven and distilled water apparatus, so arranged as to be left to itself for a long period of time without the risk of the boiler going dry, may perhaps be of interest to many chemists, and it is hoped that a few words only will be necessary to describe its working. The steam-oven, A, is of the ordinary construction, but is fitted at the side with a tube connecting it with the condenser, B. Heat is applied to A by means of a radial burner, connected with the gas supply by metallic tubing; the steam generated circulates round the drying chamber, escapes through the copper tube, C, thence through block-tin worm, and falls as distilled water in the receiver, D. The cistern, E, fitted with a Mariotte's tube, holds cold water, which falls through the tube, TT, enters the condenser, where it rises slowly, absorbing heat from the condensing-worm, until it reaches the tube leading to the boiler at a high temperature. For a cistern, an eighteen-gallon ale cask, supported on a stool, has been found to answer admirably, having the advantage of

holding sufficient water on the top to secure the two corks being air-tight. By a suitable adjustment of the Mariotte's tube, M, the rate of flow of the water can be so regulated that the level of the water in the condenser is constant, or, if desired, allowed to drop slowly into the waste pipe, while the water evaporated from A is replaced by water already near boiling. In practice it has been found necessary to allow the water to waste at the rate of about two drops per minute, the eighteen gallons lasting for over seventy-two hours, during which time ten to eleven gallons of distilled water are collected. When this apparatus was first fitted up in this laboratory it was intended to have connected the condenser directly with the town water supply, but as the water works' authorities would sanction no such connection we had recourse to the cistern, with the satisfactory result that we are in this respect quite independent of the caprice of the water-works' turncock. The several connections are made by union joints at *u u* to allow the apparatus to be taken to pieces and the boiler freed from scale. The whole apparatus may be supported upon a strong shelf, which should be protected from the heat of the burner by means of slates or asbestos



millboard. With this arrangement bulky precipitates may be allowed to remain in the steam-oven all night and found ready for further treatment next morning.

44, Loudoun Square, Cardiff.

PROCEEDINGS OF SOCIETIES.

UNIVERSITY COLLEGE, LONDON,

CHEMICAL AND PHYSICAL SOCIETY.

Thursday, October 23.

Dr. Morley gave an account of the researches of Hittorf and Kohlrausch "*On the Motion of the Ions in a Liquid undergoing Electrolysis.*" Their experiments seem to indicate that every element moves with a velocity independent of the nature of the acid residue with which it is associated, from which physicists conclude that an electrolyte contains a great number of free elementary atoms and free acid radicles,—an idea which is repugnant to the chemist, as such free atoms could not remain in the solution producing chemical decomposition.

ROYAL DUBLIN SOCIETY.

On Monday, the 18th, at the evening meetings the following papers were read in the Physical and Experimental Section :—

"*On the Asbect of the Planet Mars*," by Mr. Otto Boeddicker. It described a series of observations make with a three-foot reflector at Lord Rosse's Observatory.

"*On the Volatilisation of Zinc from German Silver Alloys*," by A. R. Haslam. He stated that his experiments in connection with the volatilisation of zinc from German silver were undertaken first to find the rate at which the alloy loses zinc by heat, and secondly the action of the nickel constituent on retarding this volatilisation. Three specimens of German silver were obtained and analysed. Their composition being then known they were heated for six hours in a current of hydrogen, weighings being taken of the alloy at the end of each hour. The results thus obtained show that the greatest amount of loss occurred in every case during the first hour of experiment, after this there is a rapid decrease in the loss sustained by the alloy. The effect of the nickel contained in the alloy on the volatility of the zinc is very striking. It was found that the alloy containing the most nickel was also the one in which the volatilisation of the zinc proceeded slowest. A specimen of brass containing the same percentage of zinc as the German silver alloys, when heated for the same time, lost nearly double the quantity of zinc. This would also tend to show that German silver appears to have much more the character of a perfect

alloy than brass. The conclusions drawn from these experiments are that the nickel retards the volalilisation of zinc in German silver alloys, and that this volatilisation is determined by the proportion of nickel present.

In the Natural Science Section, Prof. HADDON read a paper on a "*New Species of Halcampa from Malahide.*"

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 7th, 1884.

Professor W. C. WILLIAMSON, F.R.S., President, in the Chair.

"*The Pink Sun-Glow.*" by ALFRED BROTHERS, F.R.A.S.

In the *Photographic News* for September 12th, Mr. C. RAY WOODS writing from the Riffel, in Switzerland, where he has been stationed for some months for the purpose of photographing the corona, says, "But the most interesting sight to me . . . was the remarkable haze round the sun. A pink glow extended for some twenty degrees around the sun, and at the extremity of this glow was a vivid and well-defined red ring . . . On every clear day we have had here this peculiar haze has been more or less apparent."

In the *English Mechanic*, a few weeks since, a letter on the same subject appeared, written, I think, from Canada, and gave very much the same description of this very curious phenomenon.

As this pink glow has attracted attention from places widely separated, it may be of some interest if I state that many times during the present year I have noticed the same effect. As early as January I saw at mid-day the pink tint extending to at least 15° or 20° from the sun. I saw the same thing again from the East coast of Anglesea about 5 o'clock in the afternoon of the 5th July, and at the same time some of the clouds near the pink part of the sky showed the most beautiful nacreous tints, this effect lasting for a few minutes only.

About the end of August, and lasting for at least an hour after sunset, this pink tint was visible as a broad band of light, bounded at right and left by a green tint exactly complementary to the pink. Taking the place of the sun as a centre this pink light had about the breadth of the zodiacal light and extending in the same direction as when that phenomenon is seen in the western sky. By this I do not wish it to be inferred that I think the zodiacal light has anything to do with the matter, and merely refer to it to indicate the appearance of the pink light on the evening named. On the following morning there was a fainter pink tint in the sky near the sun, and several times since the same appearance has been visible at different times of the day.

It is a singular fact that some persons fail at first to see the pink colour.

It may be stated that the pink colour of the sky is not always visible when the atmosphere seems favourable for its appearance, the neighbourhood of the sun having the usual grey tint. The times when the pink colour is best seen are when there are masses of white cloud near; the colour of the sky then becomes most apparent.

Since writing the above a paragraph has appeared in "*Knowledge*" of September 26th, in which the writer calls attention to an unusual glow around the sun, and suggests that the effects may be cosmical and a real appendage of the sun. That the effect referred to is not connected with the sun seemed to me easy to prove, as, if belonging to our atmosphere, a clear moonlight night might reveal the same effect, but in a fainter degree. This supposition has proved to be correct, as on the evening of October 3rd there was an exact repetition of what I had so often seen during the year at mid-day, and at other times of the day. The coloured sketch shows very roughly the effect when the sun is seen partly surrounded by cloud, and it may be taken to show sunlight or moonlight allowing only for the different intensities of the light.

The pink glow is not persistent on any day when it may be visible. The colour may be as bright as I have attempted to show it for half an hour or more, and then all colour may quickly disappear and only the usual grayness surrounding the sun may be visible; and again the pink colour may reappear as quickly as it vanished. The colour is often seen to increase in intensity in a few moments, and always appears of a darker tint if the sun is obscured during the observation.

Mr. R. F. GWYTHER, M.A., described an Aurora seen on the night of September 13th, off Rimouski, on the St. Lawrence. When first seen the arch passed through the zenith, and stretched to the horizon on either side. The phenomenon remarked upon was that in the final stage in place of the usual streamers the light flashed across the sky, presenting the appearance of a border to hanging drapery (represented by dark sky). Of this border, the uppermost part was distinctly green in colour, whereas the lower fifth or sixth part (in breadth) was distinctly purple.

Ordinary Meeting, October 21st, 1884.

Professor W. C. WILLIAMSON, F.R.S., President, in the chair.

"*Note on the Visibility of the Moon during Total Lunar Eclipses*," by JOSEPH BAXENDELL, F.R.S., F.R.A.S.

It has been generally supposed by astronomers since the time of Kepler that the visibility of the moon during total lunar eclipses is due to light refracted by the earth's atmosphere; but in considering the phenomena of the late eclipse, and endeavouring to estimate the amount of light which could be bent by the atmosphere of the earth into its shadow. I was led to doubt whether this light was sufficient to illuminate the eclipsed moon to the extent observed in many total eclipses; and this view appeared to me to be supported by the faintness of the illumination of the dark part of the moon by the reflected light from the whole, or nearly the whole, of the disk of the earth a little before or after new moon. This illumination is not much greater than that observed in some total eclipses, but it seems difficult to suppose that the light of the narrow ring or thread of sunlight round the earth's disk as seen from the moon, and greatly subdued as it must undoubtedly be by passing through the earth's atmosphere, could be comparable with the light from an almost fully illuminated hemisphere of the earth, and it therefore became necessary to inquire whether any other source existed which would contribute light sufficient to render the moon so distinctly visible as it sometimes appeared during total eclipses.

At the time of maximum phase during the late eclipse, or when the centre of the moon was nearest to the central line of the earth's shadow, the apparent diameter of the earth as seen from the moon would be 1° 26′ 41″ greater than that of the sun, and therefore, besides the whole of the disk of the sun, the whole of the lower corona, or corona proper, would be covered by the earth, but according to the statements of observers of total solar eclipses, the outer corona extends to a much greater distance on each side of the sun than the semi-diameter of the earth as seen from the moon, and from the estimations of the brightness of this uncovered portion by some observers it seems probable that to it may be due a not inconsiderable portion of the light which renders the moon visible when immersed in the earth's shadow; and this probability is increased when it is considered that the intensity of the light of the corona, as seen from the earth, is much reduced by the absorption of the atmosphere, an effect which would not be produced in the case of the moon.

"*On the Diamond-bearing Rocks of South Africa*," by Professor H. E. Roscoe, LL.D., F.R.S., &c. See page 243.

NOTICES OF BOOKS.

The Science of Agriculture. By F. James Lloyd, F.C.S., Lecturer on Agriculture, King's College, London. London: Longmans, Green, and Co.

The title of this book, if not absolutely incorrect, is unguarded. "Science," according to the highest authorities on method, merely notes, declares, and co-ordinates natural phenomena, and traces them to their causes. To give directions for producing any results is the duty of industrial art. That Mr. Lloyd is fully aware of this distinction may be gleaned from the preface, in which he speaks of a work "from which they (farmers) could learn some of the bearings of modern science upon their art." It is the more to be regretted that he did not adopt some such title as "the scientific principles of agriculture."

In his introduction he complains, and not without grounds, that "agriculture alone, of all the arts cultivated in England, is still supposed to be best learnt by practice without either the previous or simultaneous study of the principles upon which it is founded." This prejudice he ably combats. He mentions as a natural result of the prevailing ignorance that "many farmers are ignorant of the value of the analysis of a manure, and buy anything so long as it has a powerful smell and is cheap."

This is error No. 1, and it is naturally followed by No. 2. "Finding but little benefit from the use of their artificial manure, they jump to the conclusion that artificial manuring is altogether a mistake."

The author does not overlook,—though he mentions it without any marks of regret or any inkling of its ultimate consequences—the decrease of arable land and the increase of "permanent pasture." Considering that this change means the depopulation of the agricultural districts, inventors surely ought to put forth all their efforts so as to make farming, as distinguished from grazing, more profitable.

In a well written chapter on the origin of soils, in which we find a brief abstract of Darwin's researches on the soil-forming operations of the earthworm, Mr. Lloyd expresses a very justifiable regret that we have as yet no geological map of the surface of Britain. Hence, owing to the frequency of transported soils the ordinary geological maps are of little use to the farmer.

As the essential mineral constituents of a soil the author enumerates three—lime, potash, and phosphoric acid. He does not, however, with Ville, recommend the addition of lime in all cases. On the contrary, after giving the analysis of certain soils, he remarks that they "possess sufficient lime, and to add more would be a waste of money."

In the chapter on the physical properties of soils a common confusion is pointed out. Sandy soils are really heavier than clays—a cubic foot of the former weighing more than the same bulk of the latter. Yet farmers are in the habit of calling sandy soils light, because they are easily worked, and clay soils, for the contrary reason, heavy.

The relation of different classes of soils to heat are fully explained. The fact is cited that at noon, on a July day, the temperature of the air being 90°, a thermometer placed about an inch below the following soils gave these readings:—Quartz-sand, 126°; garden soil, 115° F.; yellow sandy clay, 100° F., and chalk soil, 87° F.

The presence of an excess of moisture in keeping down the warmth of a soil, and "indirectly, therefore, its plant producing power," is fully admitted.

Among the physical causes of barrenness we find mention of ferruginous pans, such as may be seen in the neighbourhood of Wellington College. Iron sulphide and sulphate (ferrous) the author considers as not merely injurious in themselves, but as indicators that the soil is not sufficiently aërated.

In discussing the improvement of soils Mr. Lloyd decidedly traverses the notion of Sir J. B. Lawes that "profitable agriculture involves a slow but continuous exhaustion (of the fertility) of the soil."

The loss of combined nitrogen in the drainage-water issuing from the soil is duly recognised. According to an analysis by Professor Frankland, here quoted, such drainage water contained 21·03 parts per million (=1·472 grains per gallon) of total nitrogen, of which 20·40 was in the state of nitrates and nitrites. Hence it is recommended that the land should never be left without a crop longer than is absolutely necessary, as the drains discharge much less water whilst the land is under crop.

We perceive a slight discrepancy: In Prof. Frankland's analysis just referred to we find that the drainage waters contain 0·08 part per million of ammonia. But two pages further we read:—"As no traces of ammonia can be discovered in drainage waters, &c."

In speaking (p. 111) of the improvement of soils, Mr. Lloyd writes:—"If lime, however, is at times beneficial it is not always so, and even upon land where in moderation it would be advantageous, its application is capable of being carried to excess." Soils containing 2 per cent of lime the author holds will not require liming except for special purposes. Gypsum, it is here stated, is used as a means of giving lime to grasses, clovers, and mustard, but "apart from the lime which it contains there are no facts to show that it possesses peculiar properties." Is there any reason why, as regards the use of gypsum, the experience of British farmers should differ so greatly from that of their neighbours across the Channel?

In considering farmyard manure we find Dr. Voelcker's analysis quoted, in which the total nitrogen = ammonia 0·780, whilst the total phosphate of lime is given as 0·955 per cent. To these figures we may have occasion to return.

The result of liquid manure is said to have been "not a success, either in the crops or financially."

Concerning the utilisation of human excreta, especially in the form of sewage, Mr. Lloyd speaks unfavourably:—'As no system has yet been discovered of taking out of solution the valuable portion of the sewage, viz., its nitrogen, consequently all sewage manures are of necessity poor manures, and seldom worth the price given for them."

To this somewhat rash statement may be opposed the analysis of a sewage manure by Dr. Voelcker:—"Containing nitrogen = ammonia 3·41 per cent, and phosphate of lime 2·35 per cent." If no means has yet been devised of taking out of sewage its organic nitrogen, whence came the above nitrogen? Further, if this manure, which contains nearly five times as much nitrogen as farmyard manure (see Dr. Voelcker's figures above cited), and more than twice as much phosphate of lime, is a "poor" manure, what must farmyard manure be?

A little further Mr. Lloyd says:—"The most recent and one of the best methods of utilising the sewage farm is in the cultivation of vegetables. Many of the most flourishing market-gardens around Paris are sewage farmed." These gardens certainly produce heavy crops of strawberries, lettuces, cabbages, &c. But all these come in late, when the markets are well stocked, and prices rule low. This is exactly what must happen if the principles which Mr. Lloyd has laid down on the temperature of damp soils as compared with dry soils are correct. Hence it is only in tropical and subtropical regions where there is heat enough and to spare that irrigation really works well.

The author's remarks on ensilage are excellent, and as far as England is concerned will go far to dispel the nimbus in which this novel process has been enshrouded. He shows that silage is less valuable than hay, and adds "that the farmer must still endeavour to make hay while the sun

shines." If the sun does not shine he can make hay of superlative quality by means of the Gibbs drying machine.

We regret that we cannot carry further our examination of this excellent work, and can merely express our conviction that it will be productive of the greatest service to the British farmer.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the year 1882. Washington: Government Printing Office, 1884.

This report, like the proceedings of great public bodies in most countries, has the disadvantage of appearing considerably after date. Hence the records of "recent scientific progress," though ably drawn up, have lost much of their interest. The summary of chemical discovery is from the pen of Professor H. Carrington Bolton. He notes as a proof of the increasing activity in research that "the fifteen principal chemical journals of America, England, France, and Germany publish annually about 18,000 pages; in this rough estimate journals of physics and transactions of societies are not included, and both classes of serials contain much chemical matter.

Dr. Bolton refers to the syntheses of tyrosine and uric acid, to the activity shown in the revision of the organic weights, and to the progress made in unravelling the knotty problem of the rare earths in cerite, samarskite, and gadolinite.

Professor G. F. Barker, of the University of Pennsylvania, reports on physics. He remarks that of the four hundred and thirty memoirs which he has abstracted in drawing up his report, two hundred and four, or nearly one half, refer to subjects connected with electricity and magnetism.

Mr. Cleveland Abbe furnishes an elaborate, we might even say voluminous, report on meteorology, a subject which, from its obvious practical importance, commands a great and increasing interest in America. His abstracts have the disadvantage of being drawn from one sole source.

The general activity of the Smithsonian Institution is great and most satisfactory.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 18, November 3, 1884.

Conditions of Equilibrium of a Liquid Plate submitted to Electro-magnetic Actions.—G. Lippmann.—Whatever may be the form of the space occupied by the liquid in the distribution of the electric currents there is required for an equilibrium that this space should be limited by partitions arranged as sections, so as to render uniform the conjugated function of the electric potential. The law of the pressures developed along the outline is the following:—These pressures have the conjugated values of those of the electric potential along the outline.

Portable Electric Lamps.—G. Trouvé.—This paper requires the two accompanying illustrations.

Decomposition of Copper Oxide by Heat.—E. J. Maumené.—The author criticises the paper of MM. Debray and Joannis, and contends that when the temperature is raised to the point of fusion a new chemical action is set up. The cuprous oxide formed by the heat combines with the cupric oxide not yet decomposed, so as to form a saline oxide. In a former paper submitted to the Academy of Sciences, April 8th, 1844, he gave various proofs that Cu_5O_3 is a compound. This oxide on dissolving in acids gives a brown colour, whilst cupric oxide gives a blue and cuprous oxide a colourless solution. Cuprous oxide, if dissolved in melted glass, gives a colourless mass, cupric oxide a fine green, but Cu_5O_3 that splendid red so much admired in the windows of old churches.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xiii., Part 3.

Relative Heat-Conductivity of Different Soils.—Dr. F. Wagner.—The author's conclusions are that the heat-conductivity of a soil is so much the greater the more densely its particles are packed together. The difference thus occasioned is the more considerable the higher the proportion of water. In a dry soil the heat conduction rises with an increase in the size of the particles of the soil. Water increases the conductivity of the soil considerably, the more the larger its proportion in the soil, other circumstances being equal.

Influence of the Stratum of Vegetation and of Shade upon the Physical Properties of the Soil.—Prof. E. Wollny.—Soil covered with living herbage or dead vegetable matter (leaves, straw, dung, wood, &c.), is colder in summer and warmer in winter than bare soil under otherwise similar conditions. The difference of temperature is greatest in summer and least in spring and autumn. Bare soil heats more quickly in spring and cools more quickly in autumn than that covered with living or dead vegetable matter. The fluctuations of temperature are much smaller in covered than in bare soil.

On Manuring with Sulphuric Acid.—Dr. H. Fresenius.—Schröder, of Berlin, has some time ago advised farmers to apply sulphuric acid in a direct manner to their fields. Fresenius points out that a dressing of sulphuric acid might render phosphates soluble in a soil free from lime, but that in general no action would be visible. In experimental trials the result never covered the cost of the acid.

Manuring with Nitrogen and Phosphoric Acid for Barley and Oats.—Prof. Maercker.—With barley phosphoric acid was most effectual, whilst nitrogen had little action. With oats the result was reversed.

Manurial Experiments with Superphosphate containing Crude Ammonia.—Prof. Wollny.—The superphosphate was prepared by Bolton and Wanklyn's process, the gas, freed from tar, being allowed to pass through chests in which the superphosphate is supported on hurdles. Superphosphate thus prepared containing 0·7 to about 1 per cent ammonium sulphocyanide, used in the ordinary proportion of 500 kilos. per hectare has upon almost all plants the same effects as ammoniacal superphosphate containing the same proportions of nitrogen and phosphoric acid, but free from sulphocyanides.

The Physiology of the Formation of Milk.—Hans Thierfelder.—Serum-albumen is probably the material from which caseine is formed by a ferment present in the milk-glands.

Influence of Unpeeled Cotton Seed Cake upon the Production of Milk.—Prof. M. Sievert.—The result of the author's experience was unfavourable.

Researches on the Influence of Heat and Light upon the Development of Plants.—Prof. Hellriegel.—At a constant temperature of 40° in the soil the roots of barley cannot develop themselves. A constant temperature of 30° is not destructive, but decidedly injurious. A constant temperature of 20° is the best adapted to the wants of the plant, but one of 10° is not distinctly injurious.

On Blue Milk.—Dr. Schmäger. The author ascribes blueness in milk not always to bacteria but to the presence of iron.

Examination of the Elementary Composition of Certain kinds of Wood in Connection with Calorimetric Experiments on their Combustibility.—E. Gottlieb.—From the *Journal fur Practische Chemie*.

Cosmos les Mondes.
No. 6, October 18, 1884.

This number contains no chemical matter.

No. 8, November 1, 1884.

Determination of Temperatures at a Distance by Means of the Telephone.—Dr. Lenz.—Let there be two stations, M and N, connected by two wires, one of iron and the other of silver, soldered together at both ends. If the soldering of the station M is at a different temperature from that at the station N a thermo-electric current is produced in the wires. If a telephone and an interruptor are introduced into the circuit the telephone will speak until the moment when the observer at N has raised or lowered the temperatute of the soldered junction so as to render it identical with the other at M. The thermo-electric current ceases, and the telephone is silent. The exactitude of the method depends on the precision with which we determine the instant when the telephone ceases to speak—not an easy thing, for a certain resonance remains in the apparatus after the equalisation of the temperature at the two extremities. In a first series of experiments, the stations M and N being only one metre removed from each other, Dr. Lenz determined the difference of temperatures to from 1-100th to 1-200th of a degree. He concludes that with wires of iron and silver of 2 millimetres in thickness the determinations might be made at a distance of 5 kilometres, and with wires of bismuth and antimony the distance might be carried to 25 kilometres.

No. 9, November 8, 1884.

The Pollution of the Seine.—An anonymous writer suggests that the fumes and waste waters of the works of St. Denis may destroy disease-germs. It is proposed that sewage and industrial refuse should no longer be poured into the Seine, but turned into the plain of Achères. M. Desprès affirms that the water of the Seine contains above Paris 12 per cent (?) of microbia, and below the city 17 per cent, and recommends that towns above Paris should be prevented from turning their sewage into the Seine.

The Bouquet of Cider.—The cider-makers of Normandy are said to add pond-water to the crushed apples, and even a little of the drainage of dunghills, in order to hasten the fermentation and develop the bouquet of the cider.

The Waters of Paris: a New Process for the Analysis of Water.—Dr. Ménard.—The author complains of the polluted character of the water, rich in fœcal matter, which the inhabitants of Paris have to drink. River-water is supplied at the cost of 60 francs per cubic metre. The spring-water is charged at 120 francs, and, though originally pure, is contaminated by passing through dirty pipes, and when scarce is often enriched with more or less Seine water. The new method of analysis is the gelatin process.

Constitution of Clouds.—M. le Goarant de Tromelin.—The author denies that clouds and fogs consist of hollow spheres of water.

No. 10, November 15, 1884.

Liquefaction of Gases.—Dr. Tommasi.—From a note inserted in the "Antologia" di G. P. Viesseux (vol. xxvii., 1827, Florence) it would appear that the first to liquefy air and hydrogen was Perkins, who had at command a machine exerting a pressure of 2000 atmospheres. Viesseux does not state his authority. Dr. Tommasi raises the important question whether the air operated on was absolutely dry.

History of the Germ Theory.—It appears that the celebrated Athanasius Kircher, in his work on the plague (*Scrutinum physico-medicum Contagiosæ Luis quæ pestis dicitur*), published at Rome in 1658, attributed the origin of epidemic diseases to germs, or, as he called them, animalcules. He contended that each kind of putrefaction gives rise to a special virus which produces a definite species of malady.

Journal de Pharmacie et de Chemie.
Series 5, Vol. x., November, 1884.

The Volumetric Determination of Manganese.—M. Schlagdenhauffen.—An examination of the method of Leclerc. The author shows that it is essential to operate on a concentrated solution, with the aid of heat and in presence of an excess of nitric acid.

Second Memoir on Flour.—M. Balland.—A continuation, nor susceptible of useful abstraction.

MEETINGS FOR THE WEEK

MONDAY, 24th.—Medical, 8.30.
—— Geographical, 8.30.
—— London Institution, 5.
TUESDAY, 25th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 26th.—Society of Arts. 8. "The International Health Exhibition," by Ernest Hart.
THURSDAY, 27th.—Royal, 4.30.
—— Society of Arts, 8 (Howard Lectures.) "The Conversion of Heat into Useful Work," by W. Anderson, M.Inst. C.E.
—— Philosophical Club, 6.30.
FRIDAY, 28th.—Quekett Microscopical Club, 8.

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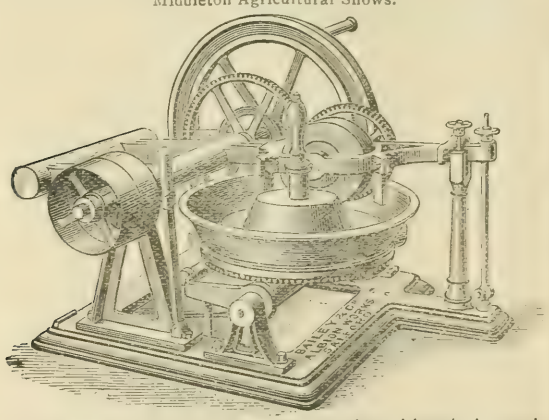

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THE CHEMICAL NEWS.

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A RE-DETERMINATION OF THE ATOMIC WEIGHT OF CERIUM.

By HENRY ROBINSON, B.A.,
Assistant to the Professor of Chemistry in the University of Cambridge.

HAVING worked a good deal during the last few years on the preparation of pure compounds of the cerium and yttrium metals, I was led to seek some method by which I might obtain their anhydrous chlorides in such a state of purity that it would be possible to make from them re-determinations of the atomic weights of the metals. In April last year, I succeeded in preparing anhydrous cerium chloride (and in this paper I shall confine myself to that metal) by passing dry hydrochloric acid gas over what I may call air-dry cerium oxalate, heating it at first gently, so as not to char the oxalate, and then, as the operation proceeded, increasing the temperature to a full red heat. The chloride so obtained was perfectly white, and, when thrown into water, dissolved with a hissing noise and a considerable evolution of heat, to a clear and colourless solution. I obtained the chloride so easily on the first attempt, I supposed I could repeat the experiment at will, but such did not prove to be the case, and, being much occupied with other duties, not much more was done towards the attainment of my object until the commencement of the present year. I had previously prepared a considerable quantity of pure cerium oxalate, in the following manner, from a crude yellow sulphate obtained from Schuchardt. It contained much didymium and a smaller quantity of lanthanum, besides other metals. About 250 grms. of the crude material were taken at once, and the lumps were broken down in a mortar, then it was transferred to a flask of about 3 litres capacity and 100 cub. centims. of strong nitric acid were added to it, afterwards gradually water until the bulk was about 3 litres. After shaking frequently for a day, it was allowed to settle all night, and next morning the clear liquid was syphoned into another flask. Any undissolved was left in the flask to go on with the next lot, to be treated in the same way. The clear liquid which had been syphoned off was saturated with sulphuretted hydrogen, then filtered from the reddish brown precipitate thrown down. To the filtrate oxalic acid was added, until there was no further precipitate formed; the precipitated oxalate was allowed to settle down, and the clear liquor was syphoned off and thrown away. The oxalate was then well washed with water made slightly acid with nitric acid on a filter, using a Bunsen pump, dried over a water-bath and then ignited. The oxides thus obtained were dissolved in nitric acid; the solution was transferred to a dish and evaporated down on a water-bath to a thick syrup, until it would scarcely pour from the basin. It was then transferred to two large beakers, each containing 1500 cub. centims. of boiling dilute sulphuric acid—20 cub. centims. of sulphuric acid, sp. gr. 1·84, in 1000 cub. centims. of water—well stirred and allowed to settle. There was a considerable precipitate of basic cerium sulphate; after it had settle down well, the clear liquid was syphoned off, precipitated with oxalic acid, and the above process was exactly repeated to obtain more of the basic cerium sulphate. After syphoning off as much as possible of the clear liquid from the second precipitate, both precipitates were thoroughly drained together on a filter at a Bunsen pump, and washed with dilute sulphuric acid. The washings and the clear liquid from the second precipitate were precipitated with oxalic acid, and the oxalates obtained, principally of didymium and lanthanum, were reserved for further treatment.

Bunsen's process was now to dissolve the basic sulphate, and re-precipitate as such, repeating the process until he obtained a small quantity of the pure sulphate; but I found it better from this stage to adopt Gibbs's method of treatment with lead peroxide. Accordingly I dissolved the washed and drained basic sulphate in strong nitric acid, added to the solution some lead peroxide, and boiled the whole until a small quantity of the solution diluted with water gave no precipitate with barium nitrate. If properly done, the cerium was now peroxidised and in solution as nitrate. I now allowed the excess of lead peroxide and the lead sulphate formed during the process to settle down, then decanted the clear liquid into an evaporating basin, and heated it on a water-bath until it became a thick syrup. This syrup was treated with boiling dilute nitric acid—25 cub. centims. of strong acid in 1000 cub. centims. of water—by which the cerium nitrate was decomposed into a basic nitrate which generally settled down readily, leaving only a small quantity of cerium in solution. The clear liquid was syphoned off and saved for further treatment. The basic nitrate was thrown on a filter, drained at the pump, and slightly washed with dilute nitric acid. It was removed from the filter-paper, transferred to an evaporating basin, and thoroughly heated on a water-bath until quite dry and hard, then broken up with a pestle in the dish, again set on the water-bath and heated, and, while there, drenched with boiling dilute nitric acid of the same strength as that used before. It was kept hot on the water-bath for some time and constantly stirred, then, after standing a short time, the greater part of the nearly clear supernatant liquor was poured away and the precipitate transferred to a filter, where it was drained by means of the pump and thoroughly washed with dilute nitric acid until some of the basic nitrate taken from the filter and dissolved in hydrochloric acid, so as to make a very concentrated solution, showed no trace of the didymium absorption bands. When this point was reached the basic cerium nitrate cnntaining a little lead was removed from the filter and put in a flask, hydrochloric acid was added, and the whole heated on a water-bath until the nitrate was converted into chloride and dissolved. The greater part of the excess of hydrochloric acid was evaporated away, as the oxalate of cerium, to be obtained subsequently, was found to be rather soluble when much of that acid was present. The cerium chloride was dissolved in water and the solution saturated with sulphuretted hydrogen, then filtered from the lead sulphide; the filtrate was boiled to get rid of the sulphuretted hydrogen, and again filtered to remove the small quantity of sulphur which separated out. The warm solution was then saturated with chlorine, and left to stand all night, so that if any iron was present it might be peroxidised. The cerium was then precipitated from the acid solution by well purified oxalic acid; the oxalate was allowed to settle down thoroughly, and the clear liquor was poured away. After several washings by decantation, using a dilute solution of hydrochloric acid containing about 2 per cent of hydrochloric acid, the oxalate was transferred to a funnel which held a perforated platinum plate in its neck, and well washed with boiling water, then dried on the water-bath. All the cerium oxalate I have used in my experiments was prepared in the way just described. When I had obtained a sufficient quantity, the whole was well mixed in a mortar and then placed in a rather loosely stoppered bottle. From time to time a quantity sufficient for each experiment was taken from this bottle. When I had prepared all the pure oxalate I required, I hit accidentally on a simpler mode of separating cerium from lanthanum and didymium. Instead of precipitating the cerium as basic sulphate, I evaporated the solution of the mixed nitrates of cerium, lanthanum, and didymium, obtained in the first instance, to complete dryness; then heated the brown mass over a naked flame until the brown colour entirely disappeared, and the residue became a pale yellow. On treating this yellow residue with boiling dilute nitric acid, the whole of

the lanthanum and didymium was dissolved, and nearly all the cerium was left as basic nitrate.

When preparing the chloride I weighed out for each experiment about 10·5 grms. of the air-dry oxalate, and put it in a rather wide glass-tube about 18 inches long. The tube was then placed in a paraffin bath and dry hydrochloric acid passed through it. The hydrochloric acid gas was prepared in the following way:—20 parts of oil of vitriol were mixed with 8 parts of water, and the mixture was allowed to cool; it was then poured on to 12 parts of common salt. The gas is not produced when the acid is thus diluted until a gentle heat is applied, but when it is it comes so easily that it may be regulated to come at any desired rate. The gas was first passed through a Woulff's bottle containing oil of vitriol, and with three tubulures, the third one being connected with an apparatus for producing carbon dioxide, so that when necessary that gas could be admitted without disconnecting any part of the apparatus, next through two large U-tubes containing calcium chloride, then again through a bottle containing oil of vitriol, and lastly through a U-tube filled with asbestos to catch any spray of sulphuric acid which might be produced. The gas now entered the tube containing the oxalate, and the excess, after passing through a sulphuric acid wash-bottle, was absorbed in water. Soon after the hydrochloric acid began to pass over the oxalate, water made its appearance at the exit end of the tube. When the air was expelled heat was applied to the bath, much water continued to come off, and was driven away by heating the end of the tube. When the temperature of the bath rose a little above 120°—generally at 123°—the oxalic acid began to sublime to the end of the tube and condensed there in crystals; this in its turn was driven away by heating the tube. As long as oxalic acid was seen to come off the bath was kept between 120° and 130°, and all that did show itself as oxalic acid did so between these limits.

Afterwards the temperature of the bath was allowed to rise gradually to 200°; there was no advantage in going higher, as the paraffin evaporated away and a gas furnace can easily be regulated to this temperature. I now transferred the substance, not yet completely converted into chloride, to another tube and continued the process in an ordinary gas combustion furnace. The object now was to so regulate the temperature that water was kept coming off without increasing the heat so rapidly as to char the oxalate left undecomposed. When a low red-heat was reached a slow current of carbon dioxide was passed in along with the hydrochloric acid to burn the little carbon left from a small quantity of the oxalic acid nearly always charring. When the slightly grey appearance of the chloride due to this small quantity of carbon disappeared the current of carbon dioxide was stopped, that of the hydrochloric acid was continued for an hour longer, while the chloride was kept at a full red-heat. With the hydrochloric acid still flowing over the chloride the furnace was gradually cooled until it was safe to handle the glass-tube; the exit end of the tube was then plugged, then the other end, and the tube was removed from the furnace and wiped clean from the magnesia it had been lying in. The cork of the tube was then withdrawn and the chloride slipped into the weighing flask, which was securely closed by a glass-cap well ground on to its neck. It was then quickly weighed while still quite warm. The object in weighing the chloride at this stage in the process was to make quite sure no water was absorbed before the final weighing was made, and such was found to be the case, for although there was always a small increase in weight, about 0·0025 grm. on 6·5 grms. of the chloride, it was no more than was easily accounted for by the loss that would arise from weighing the body warm. When weighing the chloride it was placed in a small flask with a closely fitting cap, and an exactly similar flask was used as a tare; the latter required the addition of 0·0005 grm. to balance the weighing flask; whatever was done to the one flask was always done to the other, and they were always kept beside one another. To avoid repetition, I may say here that in all the other weighings the body to be weighed was placed in one vessel, and another vessel as similar in material and weight as possible was used as a tare. The weight having been taken, in order to remove extraneous hydrochloric acid, the flask containing the chloride and the tare were placed over sulphuric acid and surrounded by quick-lime under the receiver of a large air-pump, which could be exhausted very rapidly to within 3 millims. of a vacuum. This was usually done during an afternoon; they were left here the whole of the two following days, and on the morning of the fourth day air, dried by passing through sulphuric acid and phosphoric anhydride, was let into the receiver. This treatment was found to completely free the chloride from adhering hydrochloric acid, as when it was dissolved its solution was perfectly neutral. The two flasks were now removed from the receiver, securely closed, and the final weighing of the chloride made; it was then cautiously dissolved in water.

In making the following determinations pure silver was used, prepared, according to Stas's directions, by precipitation from an ammoniacal solution of the nitrate by ammonium sulphite. For each experiment, after making the first weighing, I calulated how much silver was required to precipitate the chlorine of the cerium chloride, assuming at the outset the atomic weight of cerium was 141·0. I then weighed in a porcelain crucible that quantity, less about 10 m.grms., and ignited it in a current of dry and purified hydrogen, keeping it some time at a red-heat, allowed it nearly to cool in hydrogen, and then heated it again nearly to redness in air. After cooling over sulphuric acid the silver was weighed and transferred to a 20-oz. bottle, and the empty crucible was again weighed. A sufficient quantity of nitric acid, sp. gr. 1·42, was added to the silver, and the stopper of the bottle, which had been previously well ground in with emery, was tied down fast. The bottle was then placed in a water-bath, and the water was heated gradually until it boiled. It was kept at this temperature nearly an hour. There was no escape of gas at the stopper; if the stopper ever did slip, the silver being dissolved was rejected, and a fresh quantity was weighed. The solution of the silver was made some time before it was required, so that the bottle and contents were quite cool when opened. After carefully cleaning the neck and stopper of the bottle on the outside the stopper was loosened and washed down into the bottle, a little more water was added when the silver was found to be completely dissolved, and the solution to be perfectly clear. The succeeding operations were performed in a room from which daylight was excluded. The solution of cerous chloride was poured into the solution of silver nitrate in the bottle in which it was prepared, and the whole was well shaken. The additional quantity of silver required for the complete precipitation of the chlorine was added by means of an approximately centinormal solution of silver nitrate, 1 grm. of which contained 0·001064 grm. of silver. As I did not measure the quantity of the solution used, but weighed it, I discarded the ordinary forms of burette in favour of a convenient sized bulb which I fused on to a glass stop-cock; in this shape it was more easily weighed. The titration was made in an oblong box, divided into two compartments by a partition. The inside of the box was well blackened. In the partition a round hole was bored 1¼ inch in diameter; in the right-hand compartment a lamp was placed, and between it and the hole in the partition a spherical flask containing a solution of potassium chromate, so that the light from the lamp before passing through the hole had to pass through the yellow liquid in the flask. In the left-hand compartment the bottle containing the chloride was placed in such a position that the upper portion and surface of the liquid it contained was illumined by the pencil of yellow light proceeding through the hole. The burette was fixed in a stand in the box, so that it dropped the solution of silver nitrate into the bottle when the latter was in the best light. By this arrangement the

No. of Expt.	Silver used.	Cerous Chloride used.	Ratio of Cerous Chloride and Cerium to 107·66 of Silver.		Ratio of Cerous Chloride and Cerium to 107·93 of Silver.		The Atomic Weight of Cerium.	
	Grms.	Grms.	$CeCl_3$.	Ce.	$CeCl_3$.	Ce.	Ag=107·66.	Ag=107·93.
2	7·26630	5·5361	82·0248	46·6548	82·2309	46·7733	139·9644	140·3205
3	7·98077	6·0791	82·0066	46·6366	82·2110	46·7540	139·9098	140·2620
4	8·50626	6·4761	81·9652	46·5953	82·1710	46·7140	139·7856	140·1420
8	9·18029	6·98825	81·9533	46·5833	82·1614	46·7044	139·7499	140·1132
9	8·78015	6·6873	81·9968	46·6268	82·2036	46·7466	139·8804	140·2398
10	9·20156	7·0077	81·9914	46·6214	82·1970	46·7400	139·8642	140·2200
11	9·13930	9·6000	81·9881	46·6181	82·1937	46·7367	139·8543	140·2101

slightest turbidity produced in the liquid by the silver chloride is at once detected. The credit of originating it is due to Stas. With a little practice it soon becomes easy by observing the amount of turbidity produced by each addition of the silver nitrate to the chloride to know how many drops may be added the next time with safety, and as one drop of the solution of silver nitrate I used contained only 1-20th of a m.grm. of silver there was not much danger of adding an appreciable excess.

I have made seven determinations of the chlorine in cerous chloride by the method I have just described. The mean of these determinations gives 139·8584 as the atomic weight of cerium when the atomic weight of hydrogen is taken as 1; if that of oxygen is taken as 16, then the number for cerium becomes 140·2154.

I have taken the specific gravity of cerous chloride by weighing it in carefully purified benzene, and I find it to be 3·88 compared with water at 15·5°. Then making corrections for weighing in air, for both the brass and platinum weights and for the cerous chloride, I find the atomic weight in vacuo when hydrogen is 1 to be 139·9035, and when oxygen is 16 to be 140·2593. I thus find the atomic weight of cerium to be lower than Bühring did, but I defer making comments on the work of others who have preceded me until I have made some determinations of cerous bromide. This latter compound I have already succeeded in making by passing hydrobromic acid over cerium oxalate.

The ratios I have employed in this paper are those of Stas, and are as follows:—If the atomic weight of hydrogen is 1, that of oxygen is 15·96, silver is 107·66, and chlorine 35·37.

The atomic weight of oxygen being 16, that of silver is 107·93, and of chlorine 34·457.

The table above shows the quantities of silver and cerous chloride used in each experiment, and the ratios obtained.

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

THE Committee on Indexing Chemical Literature appointed in 1882 respectfully presents the following report of progress.

We have the pleasure to announce that since our last Report the following Indexes have been published by their authors, the arrangement of material being uniform with that of those previously issued.

Ozone, *second index*, by Prof. Albert R. Leeds.

Peroxide of Hydrogen, *second index*, by Prof. A. R Leeds.

Speed of Chemical Reactions, by Prof. R. B. Warder.

Starch Sugar, by Dr. E. J. Hallock.

Besides these a valuable contribution to chemical bibliography has been independently published on a somewhat different plan by Professor Albert B. Prescott and Mr. J. W. Baird. The full titles of the above will be found at the close of this Report.

Two hundred and fifty copies of our Report for 1883 have been sent to chemists throughout the United States, the Smithsonian Institution having kindly attended to the distribution by mail without expense to the Committee. This led to correspondence with several chemists who regarded the scheme of co-operative indexing favourably, and resulted in several offers of assistance.

Professor Wm. Ripley Nichols offers an Index to the Literature of Carbon Monoxide.

Professor L. P. Kinnicutt offers an Index to the Literature of Meteorites.

Dr. Henry Leffmann reports progress on his Index to the Literature of Arsenic.

Professor C. E. Monroe does likewise with reference to an Index to the Literature of Explosives.

Professor A. B. Prescott and Mr. J. T. Craig offer an Index to the Literature of Phosphorus.

Dr. H. Carrington Bolton has in preparation a second index to the Literature of Uranium.

An offer was also received of an Index to an element already on the list of those published, but was withdrawn as soon as the author had his attention called to the existing publication. This circumstance shows forcibly the advantage of co-operation through this Committee.

We are pleased to announce that in consequence of our representations the Smithsonian Institution has consented to Publish Indexes to Chemical Literature which shall be endorsed by this Committee. The Smithsonian places a limit to the number of pages which will be printed per annum, but the limit is a generous one.

By thus securing the assistance of the Smithsonian Institution, chemists are assured of a reliable and authoritative channel of publication, together with a wide circulation, and the plan of co-operative indexing will undoubtedly receive a great stimulus.

Finally, to extend more widely acquaintance with the existing Indexes, we append a complete list of those printed. A limited number of those published by the New York Academy of Sciences can be had by addressing the Chairman of the Publication Committee of the Academy, Prof. D. S. Martin, 236 West 4th Street, New York City.

Respectfully submitted,

H. CARRINGTON BOLTON, Chairman.
IRA REMSEN.
F. W. CLARKE.
ALBERT R. LEEDS.
ALEXIS A. JULIEN.

Sept. 4, 1884.

List of Indexes to Chemical Literature.

Uranium, Index to the Literature of. By H. Carrington Bolton. Annals of the New York Lyceum of Natural History, vol. ix., February, 1870. 15 pp. 8vo.

Manganese, Index to the Literature of; 1596—1874. By H. Carrington Bolton. Annals of the Lyceum of Natural History, New York, vol. xi., November, 1875. 44 pp. 8vo.

Titanium, Index to the Literature of; 1873—1876. By Edw. J. Hallock. Annals of the N. Y. Academy of Sciences, vol. i., Nos. 2 and 3 1877. 22 pp. 8vo.

* Advance Proofs from the *Proceedings of the American Association for the Advancement of Science*, vol. xxxiii, Philadelphia Meeting, September, 1884.

Vanadium, Index to the Literature of. By G. Jewett Rockwell. Annals of the N. Y. Academy of Sciences, vol. i., No. 5, 1877. 13 pp. 8vo.

Ozone, Index to the Literature of; 1875—1879. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, vol. i., No. 12, 1880. 32 pp. 8vo.

Peroxide of Hydrogen, The Literature of; 1818—1878. By Albert R. Leeds. Annals of the N. Y. Academy of Sciences, vol. i., No. 13, 1880. 11 pp. 8vo.

Electrolysis, Index to the Literature of; 1784—1880. By W. Walter Webb. Annals of N. Y. Academy of Sciences, vol. ii., No. 10, 1882. 40 pp. 8vo.

Speed of Chemical Reactions, Literature of. By Robert B. Warder. Proceedings of the Am. Assoc. Adv. Science, vol. xxxii., 1883. 3 pp. 8vo.

Starch Sugar, Bibliography of. By Edw. J. Hallock. Appendix E to Report on Glucose prepared by the National Academy of Sciences in response to a request made by the Commissioner of Internal Revenue. U. S. Internal Revenue, Washington, D. C., 1884. 44 pp. 8vo.

Ozone, Index to the Literature of (1879—1883); accompanied by an Historical-Critical Résumé of the Progress of Discovery since 1879. By Albert R. Leeds. Annals N. Y. Academy of Sciences, vol. iii., p. 137, 1884. 16 pp. 8vo.

Peroxide of Hydrogen, Index to the Literature of; 1879—1883. By Albert R. Leeds. Annals N. Y. Academy of Sciences, vol. iii., p. 153, 1884. 3 pp. 8vo.

Dictionary of the Action of Heat upon Certain Metallic Salts, including an Index to the principal Literature upon the Subject. Compiled and arranged by J. W. Baird, contributed by A. B. Prescott. New York, 1884. 70 pp., 8vo.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act*, 1871.

London, November 7th, 1884.

SIR,—We submit herewith the results of our analyses of the 188 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from October 1st to October 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of the 188 samples subjected to examination, three were found to be "*very slightly turbid.*" The remaining 185 samples were perfectly clear, bright, and well-filtered.

As regards degree of freedom from organic matter, the water supplied to the Metropolis during the past month has more than maintained the character it has now exhibited continuously for a long time past. Thus, while the mean proportion of organic carbon in the water supplied by the Thames Companies during the previous three months was 0·128 part in 100,000 parts, the mean proportion in the Thames-derived water supplied during the past month was only 0·118 part in 100,000 parts; corresponding to about two-tenths of a grain of organic matter per gallon; this excessively low proportion of organic matter being, it must be said, quite unusual for the period of the year.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

THE LATE MR. FRANK HATTON, F.C.S.

A MOVEMENT has been set on foot, with the approval of the Council, to found a memorial prize at the Royal School of Mines and Normal College of Science, South Kensington, in honour of the late Frank Hatton.

This gentleman, who so untimely met his end by a sad accident last year while acting as scientific pioneer in the service of the British North Borneo Company, was for some years a student at the above Institution. The energy and enthusiasm he displayed in the laboratory and his spirit and tact as an explorer in the wilds of Borneo show that Science has cause to regret the loss of a youthful worker full of promising usefulness. Mr. Hatton's contributions to chemistry, work done whilst a student at South Kensington, comprised papers "On the Action of Bacteria on Gases," "On the Oxidation of Organic Matter in Water by Filtration through Various Media, and on the Reduction of Nitrates by Sewage, Spongy Iron and other Agents," and one "On the Reduction of Amylic Alcohol," which were published in the *Journal of the Chemical Society*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, November 20, 1884.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

DURING the evening a ballot was held, and the following gentlemen were declared by the scrutators (Messrs. Davies and Greenaway) duly elected Fellows:—F. Broughton, F. J. Down, L. Ehrmann, F. G. Holmes, J. Hulme, C. Thompson, W. F. Wyley.

The following certificates were read for the first time:—W. P. Ashe, J. Ballard, H. M. Chapman, J. D. Johnstone, G. F. Kendall, P. C. Porter, W. C. Wise.

Dr. THORNE then communicated the substance of a paper by KHAN BAHADUR BOMANJI SOBRABJI "*On some New Paraffins.*" The reaction used by the author is the one proposed by Wurtz—

$$2C_nH_{2n+1}I + Na_2 = 2NaI + C_nH_{2n} + C_nH_{2n+2}.$$

The author gives an account of the preparation and properties of the following bodies:—Cetane, $C_{16}H_{34}$; boils at 278°, melts at 18° to 20°; its vapour density was found by Meyer's apparatus 7·9 to 7·85; theory requires 7·84. Dicetyl, $C_{32}H_{66}$, crystallising in glistening scales which melt at 70°. Ethyl-cetyl and diheptyl, boiling-point 245°.

Dr. JAPP then read a paper "*On Additive and Condensation Compounds of Diketones with Ketones*," by F. R. JAPP and N. H. J. MILLER. In a former communication

it was shown that phenanthraquinone, acetone, and ammonia react according to the equation—

$$C_{14}H_8O_2 + C_3H_6O + NH_3 = C_{17}H_{15}NO_2 + OH_2,$$

and that the resulting compound, acetone-phenanthraquinon-imide, when treated with aqueous acids, takes up water and parts with ammonia, yielding a compound of the formula $C_{17}H_{14}O_3$, which may be named acetone-phenanthraquinone. A further study of this body has led the authors to abandon the formula which was at first given, and to believe that the constitution of this substance is—

$$\begin{array}{l} C_6H_4—C(OH)—CH_2—CO—CH_3 \\ \quad\quad\quad\

than when the hydrogen was replaced by sodium, and it was interesting to find the sodium salt forming combinations which did not exist with the potassium salt.

Dr. HODGKINSON, in confirmation of Dr. Armstrong's remark, stated that zinc dissolved in sodium sulphate, but was unacted upon by the potash salt.

"*On the Application of Iron Sulphate in Agriculture, and its Value as a Plant Food*," by A. B. GRIFFITHS. This paper contains an account of further researches on this subject (*Chem. Soc. Trans.*, 1884, 71). The author has grown duplicate crops of beans, turnips, and wheat under similar conditions, excepting that one set was manured with half a hundred-weight of ferrous sulphate per acre, the other having no iron salt added. With the beans the crop with the iron yielded 44 bushels of grain; without the iron only 28 bushels were procured. The plants and the pods in the first case (with iron) contained more iron and phosphoric acid than in the second (without iron). No difference as regards these constituents was found in the seeds. In the case of wheat no very marked increase in the weight of the crop was observed, but the wheat grown with the iron seemed to be healthier, and completely resisted "rust," which attacked the crop grown without iron. With the turnips, the plot manured with ferrous sulphate gave 16¾ tons, the unmanured 13 tons of roots. The former contained markedly more iron and phosphoric acid. From some estimations of chlorophyll made by Dr. Russell it appears that the use of sulphate of iron increases the amount of chlorophyll in the leaves. An excess of sulphate of iron acts as a poison to plant life.

"*Notes on the Chemical Alterations in Green Fodder during its Conversion into Ensilage*," by C. RICHARDSON, U.S. Department of Agriculture. Prof. Kinch and Dr. Kellner have already published some observations which prove that during the conversion of grass, &c., into ensilage a considerable increase in the quantity of non-albumenoid nitrogen takes place. The author of the present paper has confirmed this result in the case of maize. Thus in a sample of original maize the percentage of the total nitrogen which existed in the non-albumenoid condition amounted to 21·2, in ordinary dried fodder 15·6, in ensilage 44·6 to 49·6, in ensilage from young maize 53·3, from older maize 47·1; so that in silos a large portion of the albumenoids is converted into non-albumenoid nitrogenous substance, while in the ordinary drying of fodder no such change takes place. This loss, according to the author, is due to the comparatively large amount of ammonia combined with the acids produced during the fermentation, and which is lost in drying the specimens for analysis. Thus from 4000 parts by weight of ensilage he obtained 8·66 of ammonium chloride = 2·266 of nitrogen. The remaining non-albumenoid nitrogen is probably present as an amide. The ensilage contained about 2 per cent of acids, of which 0·6 is lactic, the rest acetic acid. The author gives many analyses of maize and ensilage, which exhibit great variations in composition, and show how unsafe it is to generalise from one experiment.

"*On the Decomposition of Silver Fulminate by Hydrochloric Acid*," by E. DIVERS and MICHITADA KAWAKITA. In a previous note the authors stated that silver fulminate differed from the mercury salt in yielding much less than the full amount of hydroxy-ammonium chloride, and in yielding ammonium chloride. The present communication contains the results of a further examination of the action of hydrochloric acid upon silver fulminate, and in addition an investigation of the action of dilute hydrochloric acid upon mercury fulminate, and of the action of this acid upon fulminurates in relation to the production of hydroxy-ammonium chloride, formic acid, and ammonia, and of Steiner's production of oxalic acid from mercury fulminate. The silver fulminate was found to contain 71·79 and 71·76 per cent of Ag. Unlike the mercury salt, silver fulminate is fiercely attacked by concentrated hydrochloric acid, it shrivels up and decomposes with a loud hissing noise into very hot products. The authors have carried out this reaction without accident. If the heating be not checked, the silver chloride is at first orange, but rapidly loses this colour, imparting it to the acid mother-liquor. An unstable colourless substance is formed, giving an intense wine-red colour with ferric chloride in acid as well as neutral solutions. This substance is completely decomposed by heating. In all cases a small quantity of hydrocyanic acid was formed. The hissing noise of the decomposition is attended with the escape of carbon dioxide. The yield of hydroxy-ammonium chloride depends for its amount on the strength of the hydrochloric acid used. With strong acid in large excess, the temperature being allowed to rise, only 21·55 per cent was obtained out of the full yield 46 33; with dilute acid 43·52 per cent was formed. Formic acid seems to be produced in about the same ratio as the hydroxy-ammonium chloride. The yellow colouring matter mentioned above seems to be formed at the expense of that portion of the fulminate which would otherwise become hydroxylamine and formic acid. The quantity of ammonium chloride formed varies inversely as the quantity of hydroxy-ammonium chloride. If the hydrochloric acid be dilute, no ammonium chloride is produced, so that with dilute hydrochloric acid the action on silver fulminate does not differ from that on the mercury salt. The authors could not form any hydroxy-ammonium chloride or formic acid by the acid of hydrochloric acid on potassium or silver fulminurate. They have also repeated Steiner's reaction, *i.e.*, decomposing mercury fulminate by hydrogen sulphide in ether, but could not detect a trace of oxalic acid. The paper concludes with a brief discussion on the constitution of the fulminates, by Dr. Divers.

The Society then adjourned to Dec. 4, when the following papers will be read:—"Calorimetric Determinations of Magnesium Sulphate," by S. U. Pickering. "Fluorenes," by Dr. Hodgkinson.

PHYSICAL SOCIETY.

November 22nd, 1884.

Prof. GUTHRIE in the Chair.

MR. JAMES BEWSHER was elected a member of the Society.

The following notes were read by Mr. R. T. GLAZEBROOK, M.A., F.R.S., "*On the Permanence of some Standards of Electrical Resistance*." The author has had occasion to compare with ten standard B.A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 9·98335 B.A.U. at 14°·05 C., while Lord Rayleigh found the value 9·98330 B.A.U. Thus, either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent.

"*On the Effect of Moisture in Modifying the Refraction of Plane Polarised Light by Glass*." The author described some experiments he had been engaged in lately at the Cavendish Laboratory. Plane polarised light is made to fall on a plate or a wedge of glass at various angles and the position of the plane of polarisation determined. It is found that this depends greatly on the hygrometric condition of the air in the neighbourhood of the glass. If moist air be blown on to perfectly clean glass the plane of the polarisation of the emergent light is displaced from its normal position in one direction, while if dry air be blown it is displaced in the opposite direction. At an angle of incidence of 60° the difference between the two positions is from 6′ to 8′. If, however, the glass be not perfectly clean the effect of moisture is *at first* the same as that of dry air, though on stopping the draught an opposite effect is observed. The author assigns as the cause of this the heating of the surface which, as Magnus discovered, is

produced by a draught of moist air. He finds on repeating Magnus's experiment that the heating is not produced if the glass be clean, and he shows by an independent experiment that slight local heating does produce an effect on the plane of polarisation in the same direction as that due to the dry air.

Mr. Glazebrook also exhibited a Spectro-photometer, described by him in a paper read before the Cambridge Philosophical Society (*Proc. Phil. Soc.*, vol. iv., pt. vi.) and made by the Cambridge Scientific Instrument Company from his design.

A note "*On a Point in the Theory of Pendent Drops*," by Mr. A. M. Worthington, was read by the Secretary, Mr. Walter Baily. This was a note upon a paper recently communicated by the author to the Royal Society upon the measurement of the surface tension of a liquid from observations of the forms assumed by pendent drops. By making a measurement of a horizontal section of such a drop, and of the angle made by the tangent plane to the surface at the line where the section meets the surface with the horizontal, and knowing the density of the liquid, sufficient data are obtained to determine its surface tension.

Prof. Perry, remarking upon this paper, gave an account of some researches upon the subject in which some years since he had assisted Sir William Thomson. On the usually accepted theory of surface tension, based upon the behaviour of liquids in capillary tubes, at every point of the surface of a liquid the equation—

$$k p = \frac{1}{R} + \frac{1}{R'}$$

must hold, where p is the pressure at that point and the difference of pressure on the two sides of the surface, R and R' two principal radii of curvature, and k a constant. In the case of a drop, whose surface is one of revolution about the vertical, the contour may be drawn from the equation; this was done, and the theoretical drawings were made of a number of drops. These have since been compared by Sir W. Thomson with enlarged photographs of actual drops, and the results are highly satisfactory. This law no longer holds in the case of a drop at its "critical point," or that point when it is about to fall, since here dynamical action comes in.

Mr. Baily also read a paper by the same author "*On a New Capillary Multiplier*." This is an apparatus for the measurement of surface tension, and is a modification of one used by M. Despretz. From one extremity of the arm of a balance is suspended a roll of platinum foil, consisting of a strip 50 centims. long, and 5 or 6 centims. broad, rolled up, the successive convolutions being prevented from touching by rolling up with the foil a number of small pieces of hard glass tubing about two millims. diameter, which occupy the upper part of the helix, and preserve the form of the lower. The coil is cleaned by igniting it in a Bunsen flame, and then suspended with its lower end in the liquid to be examined. The increase in weight corrected for the part of the coil immersed is due to the fluid rising between the convolutions. From this the surface tension is readily calculated.

Mr. Hilger described a new Solar Eye-piece. In Prof. Pickering's eye-piece there are two rectangular prisms of glass of slightly different refractive indices. The light of the sun undergoes partial reflection at the surface separating the two prisms, the ratio of the reflected to the incident light diminishing with the difference between the refractive indices. It is found, however, that such a prism under a high power always gives a double image, due to the two glass surfaces, it being practically impossible, even under enormous pressure, to bring them into true contact. To obviate this, Mr. Hilger makes the second prism of Canada balsam, which gives the most satisfactory results, the image being pure and single.

UNIVERSITY COLLEGE, LONDON,

Chemical and Physical Society.

Thursday, November 6.

C. E. Cassal, F.I.C., F.C.S., President, in the Chair.

Mr. A. H. Fison read a note on "*Electrolysis*," in which he maintained that the ordinarily received chemical theories of electrolysis are not substantiated by any known fact, and are in direct antagonism with the fact that electrolytes obey Ohm's law, and with the migration of the ions. The theory which presents least difficulty is the physical theory of Clausius.

Dr. Morley replied at some length to the arguments from a chemical point of view.

Mr. E. Ernest Graves, F.C.S., then read a paper on the "*Estimation of Carbon in Phosphorus*." He commenced with a brief history of this subject, and stated that Leeds was first led by theoretical considerations to the belief that carbonic oxide would be oxidised by nascent oxygen; both he and Baumann stated that experiments verified this theory. On the other hand, Profs. Remsen and Southworth asserted that carbonic acid was not oxidised in the slightest degree by ozone. Recently Remsen and Reiser have described apparatus which they have constructed so as to be entirely free from organic matter. It consists in a combustion-tube containing cupric oxide heated to dull redness; then two wash-bottles containing sodic hydrate, and a third wash-bottle filled with baric hydrate; then a bell-jar containing phosphorus in convex discs, the curved surface just showing above a solution of potassic bichromate and hydric sulphate; air was passed in through the copper oxide tube on to this bell-jar, the air being kept as near 24° C. as possible. In this case white fumes were abundant during the course of an experiment, indicating the efficient working of the phosphorus. From this bell-jar the ozonised air was washed by means of a bottle containing pure water, and was then passed into a bottle containing concentrated baric hydrate, and this in turn protected from the external air by a sodic hydrate tube. Air alone, when passed through this apparatus for a sufficiently prolonged period, gave a precipitate—diminutive though it might be—in the baric hydrate solution. Ten litres of air gave a turbidity; twenty to thirty a precipitate. Phosphorus was considered a likely source of the carbon; for is not phosphorus isolated by methods similar to boron, silicon, and iron, in which carbon occurs as an impurity? Attempts to estimate the carbon in phosphorus at first failed, but the conclusion was arrived at that the carbon *must be* in chemical combination. The carbon has since been quantitatively determined. The method consists in oxidising a known weight of phosphorus by means of pure hydric nitrate, removing the oxides of nitrogen from escaping gases, and estimating carbonic acid. The quantity of carbon found was about 0·04 per cent. While the absolute quantity is small, it is sufficient to account for the results obtained, and the conclusion is that carbonic oxide is not oxidised by moist air in contact with phosphorus. Since Remsen published the above, Baumann has again affirmed that oxidation does take place, and the matter is now open to other workers to decide.

Action of the Active and Inactive Amyl Chlorides and of Amylen upon Toluen in Presence of Aluminium Chloride.—J. C. Essner and E. Gossin.—Active amyl chloride loses hydrochloric acid and yields amylen, which is immediately fixed so as to yield tertiary iso-amyl-toluen. The inactive amyl chloride loses not merely the elements of hydrochloric acid, but undergoes a molecular transformation to yield this body. The constitution of this iso-amyl-toluen may be easily deduced from this manner of formation. This body is a dimethyl-ethyl-metacresyl-methane.—*Bull. de la Soc. Chim. de Paris.*

NOTICES OF BOOKS.

London Water Supply. By Colonel Sir FRANCIS BOLTON, C.E., Water Examiner, "Metropolis Water Act, 1871." Published for the Executive Council of the International Health Exhibition and for the Council of the Society of Arts, by William Clowes and Sons, Limited, 13, Charing Cross, S.W.

THIS publication, which may be classed among the results of the late International Health Exhibition, is of very great importance not alone to municipal and sanitary authorities, but to the general public. It must, however, be duly noted that the author deals only with the existing water supply, and throws out no suggestions as to its possible extension, modification, or supercession. He describes merely what is without any reference to what might or what probably will be.

In the General Introduction we find a notice of the possible sources of supply, classed under the heads of rivers, lakes,—natural or artificial—and wells. Processes of purification are next referred to as necessary in most cases. As additions to mere mechanical filtration we find mention of the methods of Spencer and Bischoff, without any discussion of their value, relative or absolute, and of the well-known Clark process, now in successful operation in some towns for softening waters which are hard in consequence of the presence of lime as carbonate.

On the comparative advantages of the "intermittent" and the "constant" systems of supply, Sir F. Bolton speaks decidedly, giving, as we are glad to find, the preference to the latter, which is, we believe, universally in use where the water supply is in the hands of the municipality. Where cisterns are necessary the water is unavoidably contaminated by impurities suspended in the atmosphere.

Under the head of "Average Consumption" we find an interesting table of the consumption—or perhaps rather the supply of water per head in a number of the principal cities of the world. At the head of the list stands Rome, with a flow of 160 gallons per head daily. Next comes a city, not in other respects a sanitary model, *i.e.*, Marseilles, with 158 gallons. The cities of the United States are copiously supplied, Washington receiving 143 gallons, Chicago 102, Boston 73, and San Francisco 64. London receives 31¼, which is below the Paris standard (36 gallons), but far in excess of the quantity distributed at Amsterdam, Berlin, St. Petersburg, Stockholm, or Madrid. The worst supplied cities here quoted are Sanjago, with 5 gallons, Venice with 8, Seville with 7·26, Pernambuco with 7·3, Madrid with 3·3, and Durban with 2! We need not wonder that the recent fire at the last-mentioned town proved so disastrous.

The mode of charging consumers is next discussed. The author evidently prefers the system of a rate upon the annual value of the premises supplied, advancing in its favour the somewhat socialistic argument that by this method "the use of water is not restricted by any motives of economy, and the rates charged to houses of the better class admit of water being supplied to dwellings of the poorer class at a rate below what would otherwise be possible." We strongly doubt that such is the case. But however this may be, a rate upon the supposed annual value involves, in London at least, the possibility of an increase in the cost of water every five years. Surely there can be no equity in allowing a company or a municipality to charge a higher price for water without giving either a better or a more abundant supply, and without incurring any additional outlay. This very obvious contention is referred to in a subsequent chapter (p. 13). The reply of the companies is that "when the value of house property in any part of London declines they are compelled to take a reduced payment." Such cases, however, are rare. The surveyors employed in the quinquennial valuations are, we understand, paid by a percentage on the increased value which they can attach to the parish.

A further grievance is that, whilst any arrangement in a house which can lead to an increased water consumption —such as bath, fountains, stand-pipes for washing house fronts and watering gardens, &c.—is made the subject of a higher charge, there is no decrease in case of a greatly reduced consumption. We have heard of the following instance:—A tradesman, who previously lived over his shop, took a house in the country, and used the rooms formerly occupied by his family as a warehouse. He and his assistants took their meals at an adjacent restaurant. In consequence the consumption of water at the shop was reduced to a minimum. Yet the Company concerned refused to allow the smallest reduction. Perhaps the most equitable system, as far as dwelling-houses are concerned, would be to base the charge on the number of inmates. Such questions, however, scarcely fall within the purview of the CHEMICAL NEWS.

One of the proposals mooted from time to time is that of a dual water supply. It is obvious that for watering the streets, extinguishing fires, flushing sewers, raising steam for manufacturing purposes, &c., water may be used which is by no means sufficiently pure for domestic use. Sir F. Bolton thinks—and upon careful consideration we must agree with him—that an inferior water might be safely supplied for the purposes above enumerated. But he does not hold that a dual household supply of a pure and an impure water would be judicious. He points to the expense of duplicate pipes and fittings in every house. In addition there would be the danger that from mistake or carelessness the inferior water might be used for drinking or cookery. It might also happen that in a dry season the Company or the Municipality would be tempted to make an unsuspected communication between the two mains. Paris enjoys a dual supply; there is a supposed pure water from certain springs, and an inferior quality from the river, but there the complaint arises that the two qualities are not always kept absolutely apart.

In the second chapter, the subject of filtration which was touched upon in the introduction, is resumed at greater length. The questions, however, in how far any practicable process of filtration will remove not merely lifeless suspended impurities, but living organisms, such as disease germs and liquid pollution, is overlooked. The former merit is claimed for spongy iron and for the porcelain filter, whilst of others it is asserted that they withdraw soluble matter, such as dissolved mineral salts. But our author is perfectly justified in reminding the public that a filter will not remain for ever serviceable. He concludes this chapter with the remark that:—"The Water Companies are frequently blamed for delivering unpotable water, when if the true delinquent were sought it would be found to be the water consumer himself, whose lack of attention to his cisterns and filters has created the evil of which he complains." Again we read (p. 21) that "an inspection of the cisterns in houses too generally shows that they are in a state of foulness generally attributable to neglect." To this plea the reply is very obvious: were it not for the refusal, or at least delay, of the Companies to provide a constant service the cisterns would be non-existent, as, *e.g.*, in Manchester. It is not uncommon for 3s. 6d. to be charged for cleaning out a cistern. If the process is to be repeated every two months, as some experts recommend, here is a very serious addition to the cost of the water.

The proportions of the London water supply drawn from different sources for the present year are stated as follows: —From the Thames and certain chalk springs in its valley about 50 per cent of the whole; from the Lea and certain springs in its valley about 38, and from eighteen chalk wells 12 per cent. It appears that, as compared with 1866, the river-supply now forms a smaller proportion of the whole, whilst that obtained from the wells has increased. It is, however, an open question whether the water drawn from wells in the valleys of the Thames and the Lea is not ultimately obtained at the cost of these two rivers. The total quantity allowed to be drawn from

the Thames by the Companies is 110,000,000 gallons daily; the demands which may be made upon the Lea by the New River and the East London Companies is unrestricted.

The fourth chapter defines the duties of the Metropolitan Water Examiner, and enumerates the points on which he is required to report. Here we find a fact which certainly is not generally known. "None of the Companies are under any obligation to provide water sufficient for the extinction of fires; all that is required of them being to allow the gratuitious use of their water for this purpose and to grant certain special facilities, such as keeping for inspection maps showing their pipeage and the spots where the screw-cocks are placed for regulating the service and depositing keys of the fire-plugs at places prescribed by the Metropolitan Board. Sir F. Bolton remarks, with justice, that the value of constant supply for the purpose of fire extinction has been said with truth to be of even greater moment than its convenience to ordinary consumers." A delay of five minutes may make all subsequent exertions useless.

The sixth chapter discusses the quality of the water with especial reference to the reports on the one hand of Professor Frankland, and on the other by Messrs. W. Crookes, W. Odling, and C. Meymott Tidy. The author here states at the outset—"It should not be forgotten with regard to organic impurity, that not only is the amount present in filtered Thames water infinitesimal in actual quantity, but we have the distinct opinion of the last Royal Commission on Water Supply—an opinion arrived at after hearing very varied and often contradictory evidence—that the presence of a small quantity of organic matter in drinking-water is not necessarily prejudicial."

Professor Frankland, in his report,—written apparently this year—complains that as far as the Thames and Lea are concerned "it is sewage purification which has been attempted and not sewage exclusion. We have the *banal* laudation of irrigation and intermittent downward filtration followed by a condemnation of chemical treatment as effecting comparatively little improvement in the sewage, excepting so far as the coarser matters in suspension are concerned" (!). But there is the admission that "none of these processes, even when carried out with the greatest care and efficiency, offers any sort of guarantee against the admission into the Thames and Lea of noxious ingredients which may at any time be present in the sewage and which are capable of spreading zymotic disease." Thus the chief superiority claimed at one time for irrigation as against precipitation is virtually abandoned.

Prof. Frankland, before proceeding to his figures and tables, points out that the protection from pollution which is afforded by law to rivers is denied to underground waters. "That the latter may now be polluted to an unlimited extent without remedy was shown by the judgment of Mr. Justice Pearson in an action Ballard *v.* Tomlinson, recently heard in the Court of Chancery." Surely such a state of things should not be allowed to continue.

Prof. Frankland also states that it is only during the autumn and winter months that the total combined nitrogen can be regarded as any measure of pollution, whilst in the summer months it is considerably reduced by the presence of active vegetable and animal life. All the water delivered in London, excepting that of the Colne Valley Company, is pronounced unsuitable for washing.

Turning to the joint report issued by Messrs. Crookes, Odling, and Tidy, we find that these chemists have made a full analysis of one sample daily, whilst Prof. Frankland reports only on samples collected on one single day in each month. They take exception not to Prof. Frankland's methods or results, but they "protest most strongly against the peculiar modes of statement and comparison employed by him with obvious intent to disparage the river-water supply and exalt the well-water supply of the metropolis." Prof. Frankland's reports "suggest the notion that the wholesomeness and desirableness of different water supplies are inversely as the ascertained quantities of organic matter which they contain—that a water containing two-tenths of a grain of organic matter per gallon is twice as unwholesome as a water containing only one-tenth, and a water containing one-tenth twice as unwholesome as a water containing only one-twentieth of a grain—and this irrespective of any ascertainment of the chemical nature and the hygienic character of the organic matter, and irrespective of any regard to the absolute smallness, one might almost say insignificance, of even the largest quantities habitually met with. If the statement has not this implied meaning it would seem, as we take it, to have no meaning at all.

Messrs. Crookes, Odling, and Tidy further compare the mean quantity of organic matter per gallon as given in Prof. Frankland's monthly analysis of the water of the five Thames Companies for the year 1883, with the mean determinations of the Birmingham water by Dr. Hills, and of the Loch Katrine water supplied to Glasgow, by Dr. Mills. It is interesting to find that whilst the water of the five Companies contained 0·287 grain per gallon, that of Birmingham contained 0·259, and that of Loch Katrine 0·250. The difference is certainly very trifling. Furthermore, the water of the Lea, as supplied by the East London Company, contained only 0·235, and that of the New River Company, which is also largely Lea water, only 0·173. Both these river waters are therefore purer than the Loch Katrine supply.

Sir F. Bolton does not undertake to decide the questions here at issue.

The remaining portion of the work, though invaluable as a book of reference to local officials, has no direct scientific interest. In it the author gives a description of the London water works, with maps and tables of capital, income, expenditure, profits, &c.

Appendices contain the rates empowered to be charged for supply by the eight Companies, statutory powers as to dividends, and regulations under the metropolis. Finally comes an account of the display made by the London Water Companies at the late International Health Exhibition.

This work undoubtedly fills up an important vacancy in our sanitary literature.

CORRESPONDENCE.

SCIENCE TEACHING IN SCHOOLS.

To the Editor of the Chemical News.

Sir,—With reference to Dr. Armstrong's paper on the above in the Chemical News (vol. l., p. 239), I would ask chemists to consider whether it is desirable that further provision should be made for this teaching.

Surely the number of technical colleges now in existence is more than sufficient to supply any probable demand for technical instruction, and it should be remembered that the result of this wide diffusion of knowledge is to render it of less commercial value.

What has been the result (so far as chemists are concerned) of the opening of so many Science Colleges in recent years in this country? In my opinion simply to lower the rate of remuneration for work done till in many cases it is little better than that of an ordinary labourer. We have been told very often indeed during the past twelve months of the incalculable value this technical instruction was to the community at large, but very little has been said about the remuneration received by the pupils after the conclusion of their studies.

The matter is one of great importance, especially to the younger generation of chemists, and has not received the consideration it deserves. I should therefore be glad if

others would take the matter up and favour the readers of the CHEMICAL NEWS with their views on the subject. —I am, &c.,

A CHEMIST.

Nov. 24th, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chemie.
Series 5, Vol. x., November, 1884.

Note on Sulphocyanic Urine.—H. Bretet.—The substance in certain urines which causes them to turn red with ferric chloride is commonly supposed to be potassium sulphocyanide. The author maintains that it is more probably ammonium sulphocyanide formed by a molecular transformation of sulph-urea.

The Preparation of Sodium Monosulphide.— A. Damoiseau.—Of 100 parts of soda lye at 45° (probably Beaumé) the author takes 45 parts, which he dilutes with twice the bulk of water. He then passes into the solution a rapid current of sulphuretted hydrogen, letting the mixture heat. When it is saturated the other 55 parts of lye are added and the whole is well shaken together.

The Bark of Piscidia Erythrina.—M. Limousin. A purely pharmaceutical paper.

Filters.—MM. Chamberland and Maigren.—The Chamberland filter consists of a porous cylinder of ground porcelain burnt at such a heat that it is capable of transmitting liquids but not solids. It is used in Pasteur's laboratory for separating microbia from their culture-liquids. He has found that on filtering the most impure waters neither microbia nor their germs pass through. In the Maigren filter the acting medium is a mixture of powdered hydrate of lime and of bone-black. This apparatus is said to remove not merely suspended but dissolved impurities.

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 4 and 5.

The Compounds Formed by Chromium Sesquichloride with other Metallic Chlorides.—M l' Abbé Godefroy.—Chromium sesquichloride forms with the other metallic chlorides definite crystalline compounds. These compounds are all formed under identical circumstances; they are all decomposed by water with formation of hydrochloric acid, and the decomposition ceases when the liquid contains 32·5 per cent of this free acid. Under corresponding conditions double chromium bromides and iodides are obtained.

On the Fat of Suint.—A. Buisine.—The author finds in this fat, in addition to the fatty ethers of the cholesterines, cerotate of ceryl, and other compounds of alcohols of the fatty series.

Extraction of the Amines Contained in Commercial Methylamine.—A. Müller.—Methylamine contains some very volatile amines—those of methyl, and others less volatile,—compounds of higher amines beginning with propylamine. The author gives distinct methods for the separation of these two classes.

On Certain Colloidal Compounds Derived from Ferric Hydrate.—E. Grimaux.—A great number of ferric derivatives constitute colloidal bodies feebly soluble and capable of coagulating under the influence of heat or of salts. It is already known that the nitrate, the acetate, and the ferric oxychlorides present this character, which is also recognised in the alkalino-ferric derivatives of the polyatomic alcohols and in certain salts, such as potassium ferri-tartrate and the compounds obtained with arsenic and arsenious acids. The author examines in detail the alkalino-ferric derivatives of the polyatomic alcohols, the colloidal ferric salts, amongst others the arsenite and arseniate, the borate, phosphate, and silicate. The number of ferric derivatives giving colloidal solutions coagulable by heat is very great. The reason must probably be sought in the polyatomic character of ferricum Fe_2 and of the normal instable hydrate, which easily loses water and forms polymers.

A New Proof of the Non-Existence of Ammonium Hydrate.—Dr. Tommasi.—The author's view that ammonium hydrate does not exist in the so-called liquid ammonia, and that it cannot be properly compared with a solution of potassa or soda has been recently confirmed by M. Bouty in his researches on the conductivity of saline solutions. According to this savant the solution of an anhydrous alkali does not conduct electricity, whilst, on the contrary, the solution of a hydrated alkali conducts in the manner of salts. M. Bouty then observes that liquid ammonia conducts 110 times less than a salt of the same molecular weight, whilst potassa, soda, lithia, lime, and thallium oxide when dissolved in water conduct the current well. This fact cannot be explained save by admitting that the soluble metallic oxides form with water true hydrates, whilst ammoniacal gas, on the contrary, does not form with water any definite compound of a constitution analogous to the alkaline hydrates. According to the law of thermic constants it results that hydroxylamine, ethylamine, and trimethylamine, when dissolving in water, behave like ammoniacal gas, not forming true hydrates. Their solutions, therefore, should conduct the current very badly.

Note on "Dry Extract."—M. Jay.—Dry extract is a product sold for the purpose of sophisticating wines. Its chief constituents are commercial glucose, glycerin, tannin, dextrin, boric acid, and mineral salts. It may be detected by evaporating the wine to dryness and incinerating the ash, when the flame appears tinted with green, and by determining the glucose with the polarimeter according to Neubauer's method—the strong deviation to the right indicates dextrin.

Note on "Vinicolore."—M. Jay.—Vinicolore is a product sold at Toulouse, Agen, &c., for giving a factitious colour to red wines. It consists of elder-berries mixed with Biebrich red.

On Obtaining the Ash of Vegetable Liquids and Especially Wine.—M. Jay.—The author dries at 110° the extract obtained in a platinum capsule from 20 c.c. of wine. He ignites slightly so as to obtain a charred mass but not ash. He then adds a few drops of water and places it on the water-bath. The water acts upon the carbon in such a manner that it falls to a powder spontaneously, whilst the alkaline salts leave it and deposit themselves on the sides of the capsule. The desiccation is then finished at 110° to 115°, and the residue ignited. The author thus quickly obtains a very white ash without any loss of the alkaline salts.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xiii., Part 4.

Report on Field Experiments with Summer Corn.—Prof. Emmerling.—Not calculated for useful abridgment.

Fermentation of Cellulose and its Solution in the Intestine.—H. Tappeiner.—The principal products of the fermentation of cellulose in the intestines of the ruminants, &c., are carbonic acid, hydrogen sulphide, and methane. It is not truly digested like the carbohydrates.

Motion and Milk-secretion.—Prof. H. Munk.—Moderate muscular exercise increases the yield of milk, but strong motion reduces the quantity.

Chemical Researches on the Development and Nourishment of the Silk-worm (Bombyx Mori).—Dr. O. Kellner.—Not adapted for abstraction.

Influence of Heat and Light on the Development of Plants.—Prof. Hellreigel.—In this concluding portion of his memoir the author discusses the comparative action upon plants of direct and diffused light and their development in coloured light.

Researches on Chlorophyll. – A. Tschirch.—From the *Berichte der Deutsch. Chem. Gesellschaft.*

A New Saccharine from Lactose.—Dr. H. Kiliani.—The compound in question, isosaccharine, is obtained by the action of lime upon milk-sugar.

MISCELLANEOUS

Cantor Lectures.—A Course of three Cantor Lectures on "The Use of Coal-Gas," will be delivered at the Society of Arts, by Mr. Harold B. Dixon, M.A., on Dec. 1st, 8th, and 15th. The subject of the first lecture will be on "The Composition of Coal-Gas, its properties, its combustion"; the second, "Coal-Gas as a source of Light"; and the third, "Coal-Gas as a source of Heat."

Commercial Arbitration.—At the request of the Council of the London Chamber of Commerce, the London Jute Trade Association has nominated the following seventeen gentlemen to act as Arbitrators in difficulties which may arise suitable for arbitration in the various branches of the jute trade, in connection with the Arbitration Scheme of the London Chamber of Commerce:—As Brokers — Messrs. F. J. Barber (Barber Bros.), J. C. Duncan (J. C. Duncan and Co.), F. Ferrier, J. Johnson (Rouse and Co.), C. Patterson (Cox, Patterson, and Co.), D. Falconer (D. Falconer and Co.), and J. Scott. As Merchants—Messrs. J. Douglas (Robinson, Fleming, and Co.), Gastav Green (Rehder and Co.), G. Henderson, Jun. (G. Henderson and Co.), F. Eisenlohr (Oesterley and Co.), E. E. Petrocochino (Petrocochino Bros.), J. A. Ralli (A. Agelasto and Co.), A. A. Vlasto (Ralli Bros.), and W. F. Malcolm (W. F. Malcolm and Co.). As Dealers and Manufacturers—Messrs. J. T. Ritchie (W. Ritchie and Sons), and W. H. Hindley (W. H. Hindley and Co.). List of arbitrators are now complete for the Chemical, Leather, Coal, Printing and Allied, Textile, Wine, Carriage Building, South African and West African Trades, and are at the disposal of merchants and traders of the City of London (whether members of the Chamber or not) who may desire to submit their disputes to the jurisdiction of the London Chamber of Commerce.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

A New Method of Making the Purple of Cassius.—An alchemist named Cassius, living at Leyden, discovered in the year 1683 that a certain mixture of the solutions of tin and gold produced a fine purple-coloured precipitate, which has ever since been known by the name of "Purple of Cassius," and is much used to give a ruby colour to earthenware, glass, and artificial stones. Attempts almost innumerable have been made to ascertain the nature of this singular compound, but the results have been so contradictory as tended rather to mystify than explain the origin of its peculiar colour. Moreover, all the efforts used to produce a similar colour by other means have totally failed; so that at the present time the greatest uncertainty exists concerning its true nature, for some chemists regard the colour as an effect of metallic gold in the compound, and this is the most common view of the matter; whilst others suppose the colour to be due to an imaginary oxide of gold not yet isolated: but all chemists agree in considering tin indispensably necessary to the formation of the purple. I am about, however, to show that this latter opinion is incorrect, because a beautiful purple having the properties of the Purple of Cassius can be made without the use of tin, and perhaps the few observations which I shall add concerning the composition of this new purple may tend to elucidate the nature of the Purple of Cassius, though it must be borne in mind that the said observations are the result of very small experiments, and require to be confirmed upon a larger scale. The principal agent employed in the new process is a fluid, to which, for want of a better term, I employ the name Phosphuretted Water, since it appears to be merely a solution of phosphorus in water, though no such solution is mentioned in any book that I know of. It does not affect the colour of neutral litmus-paper, nor does it act upon sulphurous acid when heated; consequently it contains neither hypo-phosphorous acid, phosphorous acid, nor the mixture usually called phosphatic acid, because all these acids decompose sulphurous acid when heated with it. To make phosphuretted water, a large glass bottle, such as a Winchester quart, having a well-ground stopper, is to be filled with recently boiled but cold distilled water, and an ounce or so of phosphorus being added, the bottle is to be closed and left for twenty-four hours in a cool place, after which the phosphuretted water may be poured out into a proper vessel, and the process repeated upon the same phosphorus as often as may be necessary. Thus furnished with phosphuretted water, we must next dissolve 7 grains of *pure* gold* and 2 grains of iron in aqua regia, and evaporate the solution to dryness by a steam heat; then re-dsssolve the residue in 2 ounces of distilled water, and add this metallic solution solution gradually to any given quantity of the phosphuretted water until the mixture becomes slightly red, when the whole must be set aside and freely exposed to the air, by which it slowly assumes a rich ruby colour, and after a time lets fall a fine purple precipitate, which is the purple spoken of. There occasionally happens in this process, exactly as sometimes happens in the process of Cassius, an unaccountable slowness in the precipitation, and the fluid remains for days, or even weeks, of a clear crimson hue, very much resembling a solution of permanganic acid, nor will agitation, or even warmth, always put an end to it, though I once observed an obstinate solution of the above kind precipitated in a few minutes by a severe thunderstorm. It will be noticed that the proportions of gold and iron directed to be used are in the proportion of one atom of each metal, which is the ratio I have always found in the precipitate, even when the iron has been in very great excess in the solution. With regard to the composition of this new purple, I offer my opinions very modestly, for the observations I have made scarcely deserve the name of experiments. When a portion of the new purple is acted on by dilute hydrochloric acid a part is dissolved, and this part consists of the basic phosphate of the sesquioxide of iron, after the removal of which the residuum has a dark colour with an obscure tinge of purple; and if it is exposed for some time to the direct rays of the sun it becomes coated with gold as if gilded; but if without this exposure we boil the residuum in concentrated hydrochloric acid a part of it is dissolved into a solution of the perchloride of gold, and the insoluble part assumes a jet-black colour, and is but very slightly acted on even by boiling concentrated nitric acid. If, however, we heat it to a dull red heat in the open air it is converted into metallic gold and phosphoric acid, and from the relative proportion of the substances thus separated I have been induced to think that the composition of the new purple is as follows:—

	Atoms.	Grains.
Proto-phosphuret of gold..	One	228
Aurate of the protoxide of gold	One	424
Basic phosphate of the sesquioxide of iron..	Three	456

—L. THOMPSON.

* The presence of copper, and also of some other metals, totally prevents the desired effect.

MEETINGS FOR THE WEEK

MONDAY, Dec. 1st.—Medical, 8.30.
—— Society of Arts, 8 (Cantor Lectures.) "The Use of Coal-Gas," by Harold B. Dixon, M.A.
—— London Institution, 5.
—— Royal, 4. (Anniversary.)
TUESDAY, 2nd.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 3rd.—Society of Arts, 8. "Electric Lighting in America," by W. H. Preece, F.R.S.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 4th.—Chemical, 8. Ballot for the Election of Fellows.
—— Society of Arts, 8 (Howard Lectures.) "The Conversion of Heat into Useful Work," by W. Anderson, M.Inst. C.E.
—— London Institution, 5 and 7.
FRIDAY, 5th.—Geologists' Association, 8.

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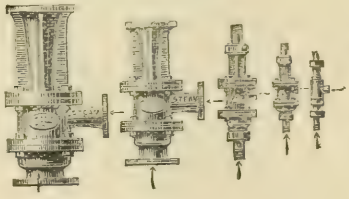

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THE CHEMICAL NEWS.

Vol. L. No. 1360.

THE COMPOSITION AND METHODS OF ANALYSIS OF HUMAN MILK.*

By Prof. ALBERT R. LEEDS, Ph.D.

In a previous paper, "On Infant Foods," which I read before the College of Physicians of Philadelphia, May 2nd, 1882, I alluded briefly to the investigation then in progress upon the Composition of Human Milk, and gave a tabular statement of the minimum, maximum, and average results of the analyses of forty-three samples, the total number of analyses which I had made up to that date. Since then I have analysed thirty-seven more samples, and have verified the results by a critical examination of the various methods of analysis which are in use at the present time.

In the beginning of my previous paper I asked the question, "What is human milk?" and stated that to answer this question satisfactorily we should know at least three things:—1st. All the constituents. 2nd. Their relative proportion. 3rd. Their chemical and physiological properties. It is not my present object to discuss the first and third points, except in the light of the following isolated results which were only incidental to the main object of the present inquiry.

The albumenoids and fat of a large number of samples, as obtained by precipitation with Ritthausen's solution, were extracted with ether, until the albuminate of copper ceased to give up any further traces of fat to the solvent. It then became, after drying, a very light green amorphous powder.

In order to separate the albumenoids, this powder was digested with very dilute hydrochloric acid, which carries some of the organic matter into solution along with the copper. The residue, after washing and drying at 100°, formed brownish, somewhat brittle, amorphous masses.

The percentage of cupric oxide contained in this albuminate of copper was found, in two analyses, to be 20·93 per cent and 20·63 per cent. The ultimate analyses of the albuminate, after deducting cupric oxide, yielded the following results:—

	I. Per cent.	II. Per cent.
Carbon	49·07	49·17
Hydrogen	7·15	7·22
Nitrogen	14·67	—
Sulphur	1·08	1·15

Two analyses of the total albumenoids, left behind after the foregoing treatment of the albuminate of copper with dilute hydrochloric acid, gave the following figures:—

	I. Per cent.	II. Per cent.
Carbon	52·39	—
Hydrogen	7·02	—
Nitrogen	13·64	13·50
Sulphur	1·49	—

The albumenoids, separated by hydrochloric acid from the copper albuminate, were digested with 50 per cent alcohol, at the boiling-point. On cooling, the filtered solution deposited a white, flocculent, voluminous precipitate, whilst the residue on the filter formed a somewhat brownish mass.

This precipitate would correspond to the "caseo-protalbin" of Danilewsky (*Jahresb. der Thierch.*, 1880, 186), and the residue, which was much the larger in amount, to his "caseo-albumen."

An analysis of the caseo-protalbin gave:—

	Per cent.
Carbon	55·86
Hydrogen	6·07
Nitrogen	17·17

An analysis of the "caseine," obtained by Makris in quite a different manner from Woman's Milk, yielded for its composition:—Carbon, 52·35 per cent; hydrogen, 7·27 per cent; and nitrogen, 14·65 per cent.

The foregoing analyses render evident that the bodies examined are not homogeneous, and in every case the process of separation left behind mixtures of substances the true nature and composition of which are at present unknown. Moreover, the deportment and properties of the bodies examined are such as to lead one to the conclusion that the investigation was being conducted not upon bodies in the condition and with the properties which they possessed originally in woman's milk, but upon substances whose composition and properties had been altered by the operation of the reagents employed.

It had been the intention of the author to endeavour to isolate the various constituents, at present very imperfectly known, of the fat of human milk. This desire had been increased by the fact that the ethereal extract of the copper albuminate obtained from numerous samples, although not by any means from all, was coloured emerald-green by some copper salt. As to the chemical nature of this copper salt, going as it does in perfect solution in ether, I have no knowledge. Unfortunately the entire mass of fats was lost by accident in the early stages of manipulation, and I shall have considerable difficulty in again procuring sufficient material to work upon. No sample of cow's milk which I have analysed yielded to ether an emerald-coloured solution. The unknown body is peculiar to woman's milk.

Methods of Analysis.

Passing by the methods of analyses which were employed when the nature of the difficulties to be overcome was imperfectly understood, and omitting from discussion in this paper the earlier results as obtained by Meggenhofen, Payen, Henri and Chevallier, L'Héritier, Quevenne, Simon, Clemm, Sherer, Donné, Heilen, Regnault, and Lehmann, the first method claiming our attention is that made use of by Vernois and Becquerel, in their essay "Du Lait chez la Femme," Paris, 1853.

Although regarded by the authors of the process as the smallest which they could employ, the amount of milk regarded by Vernois and Becquerel as necessary for analysis is excessive, being 60 grms.

Total Solids.—Of this 30 grms. are taken for determination of total solids, which are found by evaporation to constant weight at 80° C. It is evident that the evaporation of so large an amount at so low a temperature not only requires so very many hours, but presents great difficulties in the way of expelling the last traces of moisture.

Fat.—The total solids are exhausted on a filter with ether. The loss in weight is set down as fat. Or the ethereal extract after evaporation gives the weight of fat directly.

The estimation of fat by loss of weight involves numerous sources of error. And even the direct estimation according to this method is erroneous, inasmuch as ether very partially exhausts a dried residue of this nature. Consequently, the figures obtained by Vernois and Becquerel for fat are much too low, the average in 89 samples being only 2·67 per cent.

The other 30 grms. are coagulated by boiling with some drops of acetic acid. The filtrate contains sugar, extractive matters, and soluble salts.

* Read, by invitation, before the College of Physicians of Philadelphia, May 7th, 1884, and reprinted by permission from advance-sheets of its Transactions.

Milk Sugar.—Its determination by the saccharimeter, as performed by Vernois and Becquerel, gives less accurate results than those obtained by direct chemical methods.

Albumenoids.—The authors regard the nature of the extractive matters as so entirely unknown as to make their determination by analysis impossible, and set down under one head what they denominate "caseum and extractive matters." Its amount is found by subtracting the sum of the weights of fat, sugar, and ash from the total solids. If it were possible by their method to determine these four quantities correctly, the difference, which they style caseum united with extractive matters, would be the albumenoids. But, otherwise, the difference represents the algebraic sum of the errors committed in the various determinations, and this difference, in the present instance, the amount of fat and sugar as stated by Vernois and Becquerel being much too low, is correspondingly too high, being 3·92 per cent.

Analysis by the same Method as that usually employed for Cow's Milk.—This method, which is practised by some of the public analysts of New Jersey and New York, and which is a somewhat modified form of Wanklyn's, will be found stated in Cairns's "Quantitative Analysis," p. 204.

The results obtained on sample of woman's milk, Laboratory No. 1133, were as follows:—

	Per cent.
Ash	0·21
Fat	2·62
Albumenoids	2·60
Milk sugar	8·19
Total solids by summation	13·62
Total solids by evaporation	13·63

The fat, as thus determined, is too low, although it was extracted by digesting the solids left after evaporation with boiling ether six times, and with cold ether as many times more.

The sugar is too high. After weighing it was redissolved in water, and the amount of albumenoids contained in it determined. This was 0·78 per cent. which, subtracted from the sugar, as determined in accordance with the method, left 7·41 per cent, which is the correct result.

The albumenoids are also too high, and the excess is still greater when the albumenoids contained in the sugar are added to those as determined in accordance with the method, the total being 3·38 per cent. This excess is due to fat.

Correcting the results, as found directly by the method, by the results obtained by separately analysing the various educts, we have:—

	Per cent.	Per cent.
Fat, determined by method	2·62	
Fat, extracted from casein residue	2·18	
Actual Fat	—	4·80
Albumenoids, determined by method	2·60	
Albumenoids, contained in sugar	0·78	
Sum of albumenoids	3·38	
Deduct fat found in casein residue	2·18	
Actual albumenoids	—	1·20
Sugar, determined by method	8·19	
Deduct albumenoid found in sugar	0·78	
Actual sugar	—	7·41
Ash	—	0·21
Total solids, by summation		13·62
Total solids, by direct evaporation		13·63

*Determination of the Albumenoids by Precipitation with Alcohol.**—20 c.c. of dilute acetic acid are added to weak acid reaction, then four volumes of strong alcohol, the mixture well stirred, allowed to settle during an hour, and filtered upon a weighed filter. The precipitate is washed six or eight times with cold 60 per cent alcohol, then with ether, dried at 120° to 125° C., and weighed. The alcoholic filtrate is evaporated to small volume, the resultant precipitate transferred by means of 60 per cent alcohol to a weighed filter, washed repeatedly with the same alcohol, and finally with ether. These filtrates are again evaporated to a small volume, the precipitate obtained dissolved in water, an aqueous solution of tannic acid added, the precipitate so obtained transferred to a weighed filter, washed first with water, then with alcohol and ether, dried at 120°, and weighed. The three precipitates together contain all the albumenoids. They must be ignited, and the amounts of ash deducted. This method gives too low results when the addition of tannic acid is omitted. The trial of this method, as performed on sample, Laboratory No. 1133, yielded the following results:—

	Per cent.
Albumenoids in first precipitate	0·66
,, second precipitate	0·55
,, third precipitate	0·42
Total albumenoids so determined	1·63

The analysis of these albumenoids yielded—

Fat	0·00
Milk-sugar	0·43

Deducting this amount of milk-sugar, we have—

Total albumenoids as found	1·63
Deducting milk-sugar	0·43
Albumenoids actually present	1·20

Distilling off the alcohol and ether from the first and second precipitates, and determining the milk-sugar in the collected filtrates from the albumenoids, I obtained—

	Per cent.
Fat	4·80
Milk-sugar	6·98

These results make it evident—what, indeed, was feared during the whole course of the analysis by this method—that notwithstanding the great expenditure of time in washing these precipitates, the washing was incomplete, and some milk-sugar was left behind. This supposition is confirmed by the fact, that upon adding the milk-sugar contained in the albumenoid precipitates to that contained in the filtrates, the sum is the correct percentage of sugar.

*Determination of the Albumen and Peptone by Precipitation with Magnesium Sulphate.**—The assumption upon which this method is founded is that when crystallised magnesium sulphate is added to milk to the point of complete saturation the casein is completely precipitated, whilst the albumen and peptone are not. In the execution of the method, 40 c.c. of a saturated solution of magnesium sulphate are added to 10 grms. of milk, and afterwards crystals of the same salt are added in slight excess of the maximum quantity which can be made to enter into solution. After standing several hours, with frequent stirring, the precipitate is transferred to a beaker, and washed six or eight times with a saturated solution of magnesium sulphate. The collected filtrates are then diluted with water, a drop or two of acetic acid added, heated to boiling for a few minutes, filtered through a weighed filter, the precipitate washed first with water and afterward with alcohol, dried along with the filter at 120° to 125°, weighed, and ignited. By subtracting the weight of ash from that of the precipitate the amount of albumen is determined.

In the filtrate the peptone can be precipitated by means of tannic acid, or by phospho-tungstic and sulphuric acids.

I failed entirely in an attempt to perform an analysis

* "Handb. der Physiolog. Chem. Anal." Berlin, 1883, p. 491. Hoppe-Seyler.

* "Handb. der Physiol. Chem. Anal.," p. 492. Hoppe-Seyler.

by this method. Owing to the great density of a saturated solution of magnesium sulphate the casein did not precipitate, but formed a layer on the surface of the liquid, and so slow was the operation of filtration that I did not succeed in completely washing the casein during the course of several days.

Haidlen's Method, as Modified by Christenn. Total Solids.—Instead of drying the milk at 110° with one-fifth of its weight of powdered gypsum, as proposed by Haidlen, Trommer proposed the use of pulverised marble, and Christenn employed powdered glass, the drying being conducted at 95° to 100° instead of 110°. Christenn found that the hygroscopic nature of the gypsum and its solubility in alcohol gave rise to errors, the latter property raising the percentage of milk-sugar and diminishing the percentage of albumenoids.*

Other Constituents.—To 10 grms. of milk add 10 c.c. ether and 20 c.c. alcohol, mix thoroughly, collect the precipitated albumenoids on a weighed filter, and wash with a mixture of ether and alcohol (1·2) until the filtrate runs through clear. The precipitate, dried at 95° to 100°, gives the weight of albumenoids and insoluble salts. By ignition the weight of the latter is obtained, and the difference gives that of the albumenoids. The weight of evaporated filtrates gives the combined weight of the fat, milk-sugar, and soluble salts. The loss of weight after extraction with ether gives the fat. The soluble salts and sugar are ignited, the residue treated with hot water, the solution evaporated to dryness, and ignited. The weight of this ignited portion gives the soluble salts, and the milk-sugar is found by difference.

Note. In the trial of this method I did not wash the precipitate of albumenoids and insoluble salts on the filter, but by decanting. The precipitate was shaken up six or eight times with the mixture of alcohol and ether, and the latter then pipetted off through a weighed filter. Finally, the albumenoids were thrown on the filter and washed exhaustively with the same mixture. The method of decantation is more rapid and thorough, but even with its aid and with the use in all of 250 c.c. of the mixed solvent, the washing of the albumenoids was incomplete, as shown by the following results of an analysis performed upon sample, Laboratory No. 1133.

Analysis according to the Haidlen-Christenn method :—

	Per cent.
Fat	2·90
Albumenoids	2·19
Sugar	8·23
Ash	0·21
Total solids	13·53

These various educts of the Haidlen-Christenn method were analysed and separated into their individual constituents. The albumenoids were exhausted with ether, and the fat determined in the ethereal solution. The residue was then exhausted with water, and the sugar determined in the aqueous extract. In the final residue, containing according to Haidlen the sugar, the nitrogen was determined directly, and multiplied by 6·25 to obtain the percentage of albumenoids. The nature of the errors inherent in the method is strikingly shown when the corrected results obtained in this manner are compared with those stated in the table above :—(See next column.)

This loss of 1·26 per cent represents fat, which I did not succeed in perfectly exhausting from the sugar residue after evaporation to constant weight, although the treatment with ether was performed very many times.

Meigs's Method.† *Total Solids and Ash.*—Pipette off 5 c.c. of milk into a platinum dish and weigh. Evaporate to dryness on a water-bath to constant weight. Incinerate, best over a blast-lamp, and weigh the ash.

	Per cent.	Per cent.
Fat, extracted from the albumenoids	0·76	
Fat, extracted from sugar residue	2·90	
Fat, total as thus found	—	3·66
Albumenoids, determined by method	2·19	
Deducting fat in albumenoids	0·76	
Deducting sugar in albumenoids	0·16	
Actual albumenoids	—	1·17
Sugar in albumenoids	0·16	
Sugar in final residue	7·10	
Actual sugar	—	7·26
Ash	—	0·21
Total solids, as found by summation		12·30
Total solids, as found by evaporation		13·56
Loss		1·26

Fat.—Weigh off 10 c.c. in another dish, and wash with the aid of 20 c.c. of water into a tall 100 c.c. stoppered cylindrical graduate. Add 20 c.c. ether, stopper, shake for five minutes, then add 20 c.c. alcohol, and shake five minutes more.

Allow the cylinder to stand until the ether has risen to the top, pipette off, add 5 c.c. ether, shake, allow to separate, pipette off, and repeat this operation five times. Evaporate off the ether in a weighed dish; the increase in weight is fat.

Casein and Sugar.—The remaining contents of the graduate, after the ethereal solution of fat has been removed, are washed into a platinum dish and evaporated to dryness on a water-bath. The residue is treated with boiling-water, and allowed to stand. The undissolved casein precipitates, the solution of sugar is poured off. This latter is again evaporated to dryness, and the same process of settling and decantation repeated. This must be done four or five times, until it is found that when boiling-water is poured upon the dry sugar it dissolves completely, no flocculi of casein being seen in suspension. The casein residue is then, after being dried, treated once or twice with boiling-water to extract sugar. This sugar is added to the main portion. Both casein and sugar are then evaporated over the water-bath to constant weight, incinerated over a blast-lamp, and the losses in weight give the amounts of casein and sugar respectively.

Experimental Trial of Method. Total Solids.—In the weighing out of milk it must be poured directly into the dish in which it is weighed. If a pipette be used, the milk leaves minute particles upon its walls, and the alteration in composition thus produced is the greater, the more extensive the wetted surfaces of the measuring vessel.

Evaporation to dryness on a water-bath to constant weight is tedious, usually requiring three hours, and is neither so accurate nor so expeditious as the method of coagulation with alcohol.

Thus with sample No. 1133 :—

To 5·1195 grms. milk add 3 c.c. alcohol, evaporated to dryness on water-bath, an operation requiring one half-hour, and then to constant weight in air-bath at 105°, requiring with intervals for weighing one hour longer.

Loss of weight 0·699 grm. or 13·56 per cent.

Compare with this the results obtained by direct evaporation without coagulation.

Evaporated 5·059 grms. of same milk for three hours on water-bath.

Loss of weight, 0·6985 grm. or 13·81 per cent.

Dried the same for two hours longer in air-bath at 105°. The weight decreased to 13·59 per cent.

Dried the same for two hours longer at 103°. The weight decreased to 13·56 per cent. In other words, at the expiration of seven hours, I had obtained the same constant weight as I had found by the method of coagulation at the expiration of one and one-half hours.

The explanation of the difficulty of evaporating milk without addition of any kind is evident, the casein coagu-

* The addition of gypsum, marble, glass, sand, &c., is unnecessary and a source of error.

† *Philadelphia Medical News*, June, 1882.

lated by heat forming a skin upon the surface of the milk which renders any further evaporation very difficult. Alcohol, on the other hand, divides the milk into fine coagula, which readily permit the escape of moisture.

Fat.—When water is present, ether will extract not only fat, but substances soluble in water. This was probably the case in the present instance, and experiment confirmed the conjecture. After distilling off the impure ether, drying the fat to constant weight at 105° and weighing, the fat thus obtained was re-dissolved in *absolute* ether. In every trial a residue was left behind. This residue dissolved readily in water. It proved to be milk-sugar, and its percentage was determined and added to that found elsewhere.

Casein and Sugar.—The method has two objections. The albumenoids of milk, and more especially of woman's milk, are partly soluble in boiling water, and cannot be perfectly separated from milk-sugar by its use. In the second place, the finely-divided albumenoids left after evaporation to dryness and treatment with boiling water cannot be accurately separated by the crude method of settling and decantation. As a result, in case the albumenoids are washed in this manner so completely that they do not contain any milk-sugar, their amount will be much too low, whilst that of the sugar will be correspondingly too high. The percentage of albumenoids in the milk-sugar was determined by direct determination of contained nitrogen in the following test analyses.

An attempt was made to separate the albumenoids by decantation through a weighed filter, but the process was extremely tedious, the albumenoids so coagulated quickly gumming up the filter-paper.

The results obtained were as follows, several analyses being made of the same sample, No. 1133.

	Per cent.
Fat, originally obtained	4·77
Fat, after re-dissolving in absolute ether	4·66
Containing by direct determination, milk-sugar	0·10
Fat as originally obtained	4·82
Fat, after re-dissolving in absolute ether	4·48
1st Trial.	
Albumenoids in residue	0·79
Albumenoids in milk sugar	0·63
Total albumenoids	1·42
2nd Trial.	
Albumenoids on weighed filter	0·36
Albumenoids in milk-sugar	0·71
Total albumenoids	1·07
3rd Trial.	
Sugar as originally determined	8·30
Add sugar contained in fat	0·34
	8·64
Deduct albumenoids contained in milk-sugar	0·72
Actual milk sugar	7·92

Summary of Analyses,

	Per cent. (1)	Per cent. (2)
Ash (not with blast)	0·21	0·21
Fat	4·77	4·82
Albumenoids	0·79	0·36
Sugar	8·01	8·30
	13·78	13·69

The results obtained by Meigs's method will always differ from those by Hoppe-Seyler's, Haidlen's, and Christenn's methods, and from Ritthausen's method, by giving necessarily a lower percentage of ash, a higher percentage of fat, a lower amount of albumenoids, and a larger percentage of milk-sugar. These differences are inevitable, and depend upon errors inherent in the method.

Gerber-Ritthausen's Method.—After using for a considerable length of time the methods of milk analysis in common use, the author was led by a comparison of the results obtained thereby with those found by Ritthausen's method to abandon the other methods and adopt Ritthausen's. The latter, as modified by Gerber, has now been in constant use in his laboratory for more than two years, and hundreds of analyses have been performed in accordance with it. The author regards it as the only method known at the present time which is precise and rigidly accurate. Moreover, it is so rapid and, when familiar, so easy of execution, that its employment soon becomes a source of pleasure and satisfaction.

Details of Method. Total Solids.—Weigh off 5 grms. of milked in a tared covered platinum capsule. Coagulate with absolute alcohol (about 3 c.c. are used), and evaporate to dryness on water-bath. Transfer to drying-oven, and keep at 105° C. until constant weight is attained.

Ash.—Ignite the residue first over a small flame, and finally at a dull red-heat. Cover the dish, cool in the desiccator, and weigh.

Albumenoids.—Dissolve 63·5 grms. pure sulphate of copper in a litre of water. Prepare also a potash solution containing 50 grms. caustic potash in 1 litre.

Weigh out 10 grms. of milk in a covered beaker glass, and dilute with 100 c.c. water. Add 2·5 to 3 c.c. of the copper solution. Then run in sufficient potash to exactly neutralise the excess of sulphate, which will require about 1·25 to 1·5 c.c. of the potash. The coagulated albumenoids settle immediately, leaving the liquid clear. In testing the reaction, the stirring-rod, which has been washed and withdrawn from the solution as soon as the potash has been stirred in, is dipped into the clear supernatant liquid. A drop of this liquid should turn neutral test-paper neither blue nor red. Care should be exercised not to allow the stirring-rod to bring up particles of the coagulum, since these interfere with the reaction. The clear liquid is then decanted through a filter-paper, previously dried at 110°, and weighed in a weighing-flask. The precipitate is then stirred up with 100 c.c. water, allowed to settle, the supernatant liquid again decanted through the filter, and, finally, the precipitate is washed upon it. The beaker is thoroughly cleansed with a rubber washer, and all these filtrates, amounting to about 240 c.c., are finally made up to exactly 250 c.c. for the determination of milk-sugar.

The filter-paper containing the precipitate is then opened out upon a large watch-glass, and, after drying to a certain point, is divided up into small particles by a platinum spatula, and this comminution is repeated from time to time until finally the whole mass becomes a fine powder,

Fat.—The filter-paper containing the precipitate is gathered up and placed loosely in a proper funnel. The beaker-glass used for the precipitation is washed out with ether to dissolve any traces of fat adhering to it, and these ethereal washings are poured through the funnel and allowed to run into a small weighed flask, with which the funnel is connected by a ground-glass joint. The funnel is then connected with a return cooler, the flask carefully heated by a water-bath, and the filter-paper is made to swim in the ether condensed in the funnel for about an hour, when the extraction of fat will be complete. The ether is distilled off, the flask dried at a temperature of 105°, cooled in a desiccator, and weighed. Its increment in weight gives the amount of fat.

Albumenoids.—The residue in the filter is dried at 110°, and weighed in the weighing-flask until constant weight is attained. It is then ignited in a platinum crucible, and the weight of ash deducted. The loss of weight is the amount of albumenoids.

Milk-Sugar—This is determined in the filtrate by

Fehling's solution. The figures thus obtained are identical with those found by evaporation of the filtrate to dryness, igniting, and subtracting ash.

In case the above method is carefully followed, the sum of the several constituents as separately determined will not differ by an appreciable quantity from the amount of solid matter as determined directly by evaporation. Thus, it will be seen from the table, giving the results of 62 separate analyses of human milk (excluding Laboratory No. 1063 as being manifestly affected by some accidental error), the maximum difference is 0·21 per cent.

The average error, as determined by ordinary arithmetical methods, is 0·001 per cent. The probable error of any individual analysis, as determined by the method of least squares, is a difference of 0·0098 per cent in the sum of the several constituents as found by addition, and the sum as determined by direct evaporation.

This close agreement does not itself prove the accuracy of the methods employed. But, in connection with the fact that an analysis of the fat showed no trace of albumenoids or sugar, that an analysis of the albumenoids revealed no sugar or fat, and that an analysis of the sugar showed no albumenoids or fat, it does afford such proof.

The only serious objection to the method is that, in the precipitation of the albumenoids by Ritthausen's solution, hydrated basic sulphate of copper is precipitated at the same time, and that this hydrate does not lose its water at the temperature at which drying of the albuminates is effected. Hence, the weight obtained would be in excess of the true amount. This objection is not borne out by the results of analyses of the precipitated cupric albuminate, since I have failed to detect in it the presence of more than traces of hydrated basic sulphate.

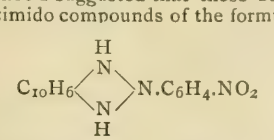
(To be continued.)

NOTE ON THE

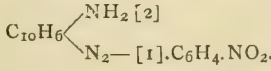
CONSTITUTION OF THE β-AZO-COMPOUNDS.

By RAPHAEL MELDOLA, F.C.S., F.I.C., &c.

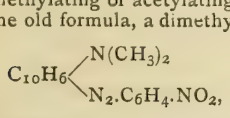
In a paper published in the March number of the *Journal of the Chemical Society* (*Trans.*, p. 106), I pointed out that the azo-compounds resulting from the action of diazo-nitraniline (para and meta) upon β-naphthylamine gave nitroso-derivatives by the action of nitrous acid, and from this circumstance I suggested that these bodies might be regarded as azimido compounds of the formula:—



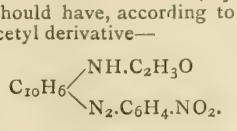
instead of ortho-azo bodies of the formula—



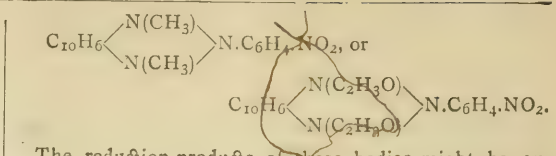
I promised to extend my experiments in this direction, and for some months past have been engaged during the intervals permitted by other investigations in studying the various reactions of the bodies in question, with the object of proving or disproving the formula suggested. The crucial test of this formula is obviously the preparation of an alkyl derivative and subsequent reduction. Thus, by methylating or acetylating we should have, according to the old formula, a dimethyl or acetyl derivative—



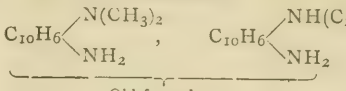
or



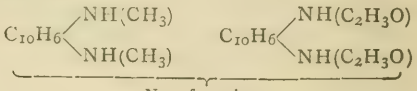
Whereas an azimido body might furnish a *di*acetyl derivative or a dimethyl derivative of the formula—



The reduction-products of these bodies might be expected to be respectively—

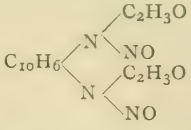


Old formula.

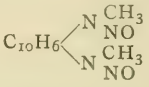


New formula.

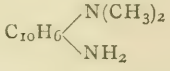
and para- or meta-phenylene diamine. The formation of a *di*acetyl derivative would thus furnish strong evidence in favour of the new formula, and this evidence would be further strengthened if the reduction-product of the diacetyl derivative gave a *di*nitroso compound by the action of nitrous acid—



although it is doubtful whether such a body would not be too unstable for isolation. The dinitroso-derivative of the reduction-product of the dimethyl derivative (new formula) might be more stable:—

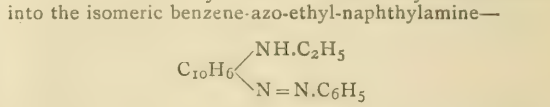


Dimethyl-diamido-naphthalene of the formula—

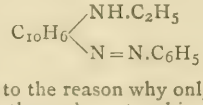


would possibly diazotise by the action of nitrous acid.

My experiments are as yet in too incomplete a state to pronounce decisively in favour of either formula, and I should not have put forward these purely speculative statements had it not been for the appearance of a paper by Rob. Henriques in the number of the *Berichte* just received (p. 2668). The author of this paper has made the interesting discovery that ethyl-β-naphthyl-nitrosamine acts upon aniline, toluidine, &c., in the sense of the equation—



The diazo-amido body becomes immediately transformed into the isomeric benzene-azo-ethyl-naphthylamine—



Speculating as to the reason why only β-naphthylamine derivatives lend themselves to this reaction and not diphenyl-nitrosamine, the author suggests that the hypothetical diazo-amido compound transforms itself so readily into the isomeric compound because the substitution takes place in neighbouring (ortho) positions.

Another explanation is furnished by the formula suggested by me in the paper above referred to, and the author proposes to test these views by ethylating the pro-

duct of the action of ethyl-β-naphthyl-nitrosamine and then reducing. According to the older view a base of the formula—

$$C_{10}H_6\begin{cases}N(C_2H_5)_2\\NH_2\end{cases}$$

would be obtained, and in accordance with the new formula this base should have the constitution—

$$C_{10}H_6\begin{cases}NH.C_2H_5\\NH.C_2H_5\end{cases}.$$

As regards this last suggestion, it will thus be seen that our respective lines of research threaten to come into collision, and without in any way wishing to check Herr Henriques's important investigation, I will only intimate my intention of continuing the experiments herein projected, and hope shortly to be able to offer some definite results for the consideration of my chemical colleagues.

I should like to take the present opportunity of stating that the diamido-azo bases of the general formula—

$$NH_2.R''-N=N-R''.NH_2,$$

described in a former paper (*Chem. Soc. Jour.*, 1883, *Trans.*, p. 433), are also undergoing investigation. For these bases, which are isomeric with the Chrysoïdines, I propose the name "Flavoïdines."

Atlas Works, Hackney Wick,
November 27, 1884.

NOTES ON THE KOETTSTORFER METHOD FOR THE EXAMINATION OF BUTTER FOR FOREIGN FATS.

By RUSSELL W. MOORE.

WHILE testing butters accurding to the methods of Hehner,* Reichert,† and Koettstorfer,‡ it occurred to the writer that an examination of vegetable oils by the last two of these methods might furnish some interesting results. The object in view was to ascertain whether it is possible to mix butter or oleomargarine with an oil in such a manner that detection would be impossible by any one of the above methods.

In every case the analysis was conducted as directed in the papers referred to.

The following oils were examined in duplicate by the Koettstorfer process; singly, by the Reichert:—

	M.grm. KOH.	C.c. 1-10th Nor. NaOH.
Olive oil	185·2	0·2
Cotton seed oil ..	191·2	0·3
Peanut oil	196·6	0·4
Palm oil	196·3	0·8
Oil beune..	192·4	0·6
Oil sweet almonds..	187·9	0·3
Poppy oil..	192·8	0·5
Rapeseed oil	183·0	0·3
Linseed oil	195·2	0·2
Cocoa butter	199·8	1·6
Cocoanut oil	250·3	3·7
,, ,, washed	246·2	2·7

It will readily be seen that none of the above oils could be mixed with butter without fear of detection by both processes, with the notable exception of cocoanut oil.

The cocoanut oil used was a refined article of evidently superior quality. Exposed to the air for more than a week it did not turn rancid nor did its characteristic odour become perceptibly stronger.

Koettstorfer fixes the limits of the number of m.grms. of caustic potash requisite to saponify a grm. of real butter as between 221·5 and 232·4. Cocoanut oil, it will be seen, exceeds by a considerable amount the highest of these limits.

After the first results were obtained it was suggested that soluble free fatty acids might be present to render the result high. Accordingly about 20 grms. of the oil were thoroughly washed with boiling water to the amount of six litres. An examination then furnished slightly lower results by the Koettstorfer process, while the figures obtained by the Reichert process were reduced in a much greater proportion. It is then possible to mix an oleomargarine with cocoanut oil so as to bring the results within Koettstorfer's limits. In proof of this the following mixtures were made and results obtained, the object being to approach nearly the limits of Koettstorfer:—

Cocoanut Oil.	Oleomargarine.	M.g. KOH per grm.
49·3 p.c.	50·7	220·0
70·2 p.c.	29·8	234·9
Washed Oil.		
53·1 p.c.	46·9	223·6
75·9 p.c.	24·1	234·9

The oleomargarine used required 193·5 m.g. KOH per grm.

It is improbable also that these mixtures could be detected by the Hehner process, since cocoanut oil yielded 86·43 per cent of insoluble fatty acids.

The Reichert process would with such a mixture be sure to show the adulteration, for the number of cubic centimetres of 1-10th normal NaOH would be under one-third the amount requisite for a genuine butter.

In Dietzsch's "Nahrungsmittel," 4th Edition, p. 212, mention is made of cocoanut oil as an adulterant of "Schmalzbutter," and in the *Analyst*, vol. vii., p. 93, a case is reported of its use to adulterate lard. In this latter case the Koettstorfer process would serve as a test, since lard requires for saponification but 195·5 m.g. KOH per grm., and an addition of only 10 per cent of the oil would raise the figures to 201.

If a process should ever be devised to render cocoanut oil completely inodourous (and it should be extensively used as an adulterant of butter), it will be seen that the Koettstorfer process would be utterly worthless as a test, and the Hehner of scarcely greater value. Thus entire reliance would have to be placed on the method of Reichert.

John C. Green School of Science,
Princeton, N.J., U.S.A.

* *Fresenius Zeitschrift*, vol. xvi., p. 147.
† *Ibid*, vol. xviii, p. 68.
‡ *Ibid.*, vol. xviii., p. 199.

A NEW METHOD FOR THE DETECTION OF IODINE, BROMINE, AND CHLORINE.

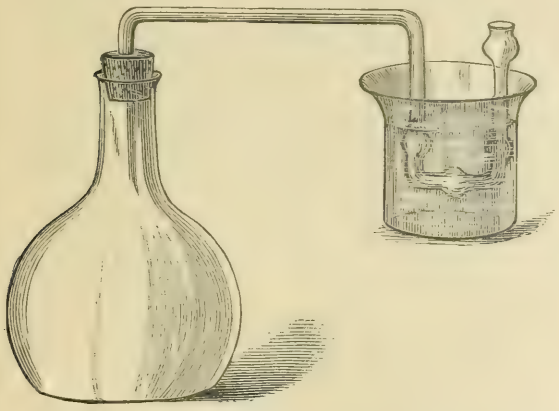
By EDWARD HART.

IF nitrates, chlorates, bromates, or iodates are present it is necessary to fuse the substance with a little sodium carbonate and charcoal to reduce them. If the haloids are united with silver it is best to fuse with sodium carbonate and extract with water, although with iodine and bromine this is not absolutely necessary (see Exp. No. 8 below).

The substance is placed in the flask shown in the figure with some water and a few drops of solution of ferric sulphate. In the bulbs are poured a few drops of dilute starch paste. The bulbs are kept cold by immersing in water in a beaker. The contents of the flask are then boiled, and if iodine is present the starch is coloured blue. This test is extremely delicate. If iodine is found the cork with the bulb tube is removed and the solution

	No.	Contains—			Reported.		
A	1.	2 grms. NaCl	0·001 grm. KI	0·005 grm. KBr	I	Br	Cl
	2.	,, ,,	0·001 ,,	0·002 ,,	I	Br	Cl
	3.	,, ,,	0·001 ,,	0·001 ,,	I	Br	Cl
	4.	,, ,,	0·001 ,,	—	I	No Br	Cl
	8.	,, ,,	0·001 grm. AgI	0·001 grm. AgBr	I	Br	Cl
B	5.	2 grms. NaCl	—	0·002 grm. KBr	No I	Br	Cl
	6.	,, ,,	0·001 grm. PbI_2	—	I	No Br	Cl
	9.	0·1 grm. NaCl	0·001 grm. KI	2 grms. KBr	trace I	Br	Cl
C	10.	0·001 grm. NaCl	0·001 grm. KI	0·001 grm. KBr	I	Br	Cl
	11.	0·001 ,, ,,	0·001 ,, ,,	2 grms. KBr	trace I	Br	Cl
	12.	—	0·001 ,, ,,	2 ,, ,,	trace I	Br	No Cl

boiled until on testing again in the same way no more iodine is found. If much iodine is present it is necessary to add more ferric sulphate solution. The bulb tube is now cleaned, charged with a few drops of water and a drop or two of chloroform, and a very small crystal of potassium permanganate added to the solution in the flask. The contents of the flask are boiled again, and if bromine is present the chloroform becomes red. The tube is now removed and more potassium permanganate and ferric sulphate added little by little, boiling between each addition until the bromine has all been driven off. A few drops of alcohol are added to the contents of the flask to decolourise any excess of permanganate, and after filtration chlorine is tested for in the filtrate with silver nitrate.



Mixtures were given to three qualitative students, neither of whom had used the test, with the result given in the Table above.

As in testing No 3 only about 1-10th of the substance given out was used for testing it is evident that an ordinary qualitative student can by this method detect the bromine in 0·0001 grm. KBr, and a very much smaller amount of KI can easily be found. It is also evident from 9, 11, and 12 that the presence of a large amount of bromine decreases the delicacy of the test for iodine.

The solution of ferric sulphate is made as follows:—Copperas is dissolved in water, oxidised with nitric acid, the solution precipitated with ammonia, and the precipitate washed by decantation and finally brought on a filter. 50 c.c. of dilute sulphuric acid (1 acid to 1 water) is then saturated with the still moist precipitate and to the solution 50 c.c. of the same sulphuric acid is added.

Lafayette College, Easton, U.S.A.
Nov., 1884.

Fluoric Apatites.—A. Ditte.—In the fluoric apatites, as well as in those containing chlorine, bromine, or iodine, arsenic and vanadic acids may be substituted for phosphoric acid, giving analogous compounds.—*Compt. Rend.*

ON THE SEPARATION OF ARSENIC FROM TIN AND ANTIMONY.

By F. HUFSCHMIDT.

THE author was induced by Prof. Classen to use along with Bunsen's process that recommended by E. Fisher, which consists in forming volatile arsenic trichloride by means of ferrous chloride and distilling it off.

The substance to be analysed, consisting of arsenic and antimony sulphides, was therefore first oxidised with ordinary nitric acid, a little fuming nitric acid being afterwards added, and was then distilled with 20 per cent hydrochloric acid (sp. gr. 1·1), exactly as directed by Fisher. The author did not, however, succeed in separating the arsenic by a thrice repeated distillation. On the contrary, even in the tenth distillate, traces of arsenic could be detected by means of hydrogen sulphide. The behaviour of a solution prepared by oxidising arsenious acid with chlorine in an alkaline solution was similar. On distillation with 20 per cent of hydrochloric acid, arsenic was detected in the seventh distillate by means of hydrogen sulphide. On the contrary, a solution of arsenious anhydride in hydrochloric acid, distilled as above, gave the result indicated by Fischer. On employing 0·1 grm. arsenious anhydride the third distillate was completely free from arsenic. On repeating the distillation of the arsenious acid oxidised by means of nitric acid or chlorine with hydrochloric acid containing 40 per cent actual HCl, it was found practicable under otherwise similar circumstances to separate the arsenic perfectly after the fourth or fifth distillation. Here it appeared, however, that not all the arsenic was condensed in the receiver, so that it had to be connected with an additional apparatus for condensation.

At the suggestion of Professor Classen it was next attempted to distil off the arsenic in a current of hydrochloric acid gas. The experiment was completely successful, the arsenic being entirely removed in a single distillation. The arsenical liquid was made up to 250 c.c. with the strongest hydrochloric acid. It was then completely saturated with hydrochloric acid gas and was then distilled in a plentiful current of the same gas. The volatility of the arsenic chloride was found to be so great that it had been almost entirely expelled before the first drops of the distillate had reached the receiver. After about 50 c.c. of the liquid had passed over, on continuing the operation, arsenic could no longer be detected in further portions of the distillate by means of hydrogen sulphide.

This method is in one sense more difficult than that of Fischer, since, in consequence of the excessive volatility of arsenious chloride, a receiver is not sufficient for condensation. The author has, therefore, modified Fischer's apparatus by connecting with the receiver a Wolff's bottle of about 900 c.c. capacity, containing 300 to 400 c.c. either of water or of potassa-lye of sp. gr. 1·1 to 1·2. To prevent an obstruction in the delivery-tube leading into the potassa-lye in consequence of the formation of potassium chloride, a glass tube, 28 c.m. in length and

11 m.m. in internal diameter, was arranged so as to dip 10 to 15 m.m. into the liquid. As the contents of the Wolff's bottle become strongly heated in the course of the operation suitable refrigeration is necessary. The author has satisfied himself by direct experiments that the last traces of arsenious chloride remain in the Wolff's bottle whether filled with water or with potassa-lye, and whether more or less arsenic is originally present. In all cases where large quantities of arsenious chloride have to be driven off the use of potassa-lye is preferable, as the distillate is otherwise more or less turbid. The author has further ascertained by especial experiments that when solutions of antimony and tin in hydrochloric acid are distilled as above in a current of hydrochloric gas, not the slightest traces of these metals can be detected in the distillate.—*Berichte der Deutsch. Chem. Gesell.*

THE DETECTION OF CYANOGEN.

By A. VOGEL.

The reaction of picric acid with hydrocyanic acid is quite distinct even when the latter is diluted 30,000 times, and, as compared with the reaction of the formation of Prussian blue, it has the advantage of giving an immediate, or at least very early, decision, whilst the other method, in case of very dilute liquids, may require days. As an aqueous solution of picric acid, if heated with alkaline lye, takes a rather deeper colour; it is recommended to use for this reaction picric acid which has been already heated with soda- or potassa-lye.

The picric acid reaction effects the detection of hydrocyanic acid in tobacco-smoke very easily. The smoke is passed through soda-lye, which is then boiled with neutralised picric acid, when the deep red-colour at once appears. The author succeeded in demonstrating the presence of cyanogen compounds in coal-gas; he passed 6 litres of gas through strong soda-lye, and then treated it with neutralised picric acid, applying heat. A deep blood-red colour at once appeared.—*Bavarian Academy of Sciences, and Chemiker Zeitung.*

THE LATE HENRY WATTS, B.A., F.R.S., F.C.S.

It having become known to some of the friends of the late Mr. Henry Watts, whose death occurred very suddenly on the 30th of last June, that his widow and family are in very straitened circumstances, an informal meeting was held at the Royal Institution on Tuesday, the 11th of November. Those present resolved to form themselves into a committee, with power to add to their number, in order to collect a fund for the benefit of Mrs. Watts and those of her children who are not of an age to provide for their own support. Dr. Atkinson consented to act as Secretary, and Dr. Perkin, President of the Chemical Society, as Treasurer.

The following gentlemen constitute the Provisional Committee:—Sir F. A. Abel, H. E. Armstrong, Edmund Atkinson, William Crookes, Warren De La Rue, James Dewar, G. C. Foster, J. H. Gladstone, A. G. V. Harcourt, Hugo Müller, E. C. Nicholson, William Odling, W. H. Perkin, W. Chandler Roberts, Sir H. E. Roscoe, W. J. Russell, W. A. Tilden, W. A. Williamson, P. J. Worsley.

Mr. Watts's public labours for the advancement of Chemical Science may be said to have begun with the translation of Gmelin's "Handbook of Chemistry," the admirable English edition of which was prepared and edited for the Cavendish Society by him. This work occupies eighteen large octavo volumes, of which the first appeared in 1849, and the last in 1871. A work scarcely, if at all, inferior to this in magnitude, and one which has perhaps been of even greater service to English chemists, both scientific and industrial, is Watts's great "Dictionary of Chemistry," which appeared from 1863 to 1881, in eight volumes, containing altogether nearly 9700 pages. Mr. Watts also edited and largely added to the second volume of the late Professor Graham's "Elements of Chemistry," published in 1858; he prepared several editions of Fownes's well-known "Manual of Chemistry," which he almost entirely re-wrote and made into virtually a new work; and in conjunction with Mr. Ronalds and Dr. Richardson he prepared for Messrs. Baillière an elaborate treatise on Chemical Technology. Up to the time of his death, and for about thirty years previously, Mr. Watts was Editor of the *Journal of the Chemical Society*, and in this capacity, as well as in that of Librarian to the Chemical Society, he became personally known to and gained the friendship of very many among the Fellows of the Society.

But although Mr. Watts's life was one of unremitting labour, the money return for his work was barely sufficient to enable him to provide for the daily wants of a delicate wife and a numerous family. It was not possible for him to provide for their future needs. But if he could not leave behind him pecuniary resources, he accumulated esteem and affection among all who knew him, which, it is confidently hoped, will prove a valuable legacy for those who were dependent on him. The following facts will show that there is great need of whatever practical proof of their regard for him and appreciation of his labours Mr. Watts's friends, and English chemists generally, may be willing to make.

For many years Mrs. Watts has been in ill-health, so that she cannot do anything for her own support and that of her family. Her only income is about £100 a year, and of her ten children only two are in a position to afford her help. They hope to contribute between them £150 a year. One son is a permanent invalid, and the four youngest children have still to be educated. A considerable expenditure is therefore unavoidable for a good many years to come, if the children are to have a fair chance of a start in life.

Subscriptions will be received and acknowledged by the Secretary, Dr. Edmund Atkinson, Portesbery Hill, Camberley, Surrey, or by the Treasurer, Dr. W. H. Perkin, The Chestnuts, Sudbury, Harrow.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, December 1, 1884.

The Hon. Sir William R. Grove, D.C.L., F.R.S., Vice-President, in the Chair.

The following Lecture Arrangements were announced:—

Professor Tyndall, D.C.L., F.R.S.—Six Lectures (adapted to a Juvenile Auditory) on "The Sources of Electricity: Friction-electricity, Volta-electricity, Pyro-electricity, Thermo-electricity, Magneto-electricity;" on Dec. 27 (Saturday), Dec. 30, 1884; Jan, 1, 3, 6, 8, 1885.

Professor Henry N. Moseley, M.A., F.R.S.—Five Lectures on "Corals and other Colonial Organisms:" on Tuesdays, Jan. 13, 20. 27, Feb. 3, 10.

Professor Arthur Gamgee, M.D., F.R.S.—Four Lectures on "Digestion" (the subject to be continued after Easter); on Tuesdays, March 3, 10, 17, 24.

Professor Dewar, M.A., F.R.S.—Eleven lectures on "The New Chemistry;" on Thursdays, Jan 15, 22, 29, Feb. 5, 12, 19, 26, March 5, 12, 19, 26.

Charles Waldstein, Ph.D. Heidelburg, Hon. M.A. Cantab.—Three Lectures on "Greek Sculpture from Pheidias to the Roman Era;" on Saturdays, Jan. 17, 24, 31.

George Johnstone Stoney, F.R.S.—Three Lectures on "The Scale on which Nature Works, and the Character of some of her Operations;" on Saturdays, Feb. 7, 14, 21.

Carl Armbruster.—Five Lectures on "The Life, Theory, and Work of Richard Wagner" (with Illustrations, Vocal and Instrumental); on Saturdays, Feb. 28, March 7, 14, 21, 28.

UNIVERSITY COLLEGE, LONDON,

Chemical and Physical Society.

Thursday, November 20.

C. E. Cassal, F.I.C., F.C.S., President, in the Chair.

Dr. Morley distributed specimens of hydroxylamine hydrochlorate prepared by the method recently described by Dr. E. Divers (*Journ. Chem. Soc.*, 1883.)

Mr. M. Church gave a short note "*On the Relative Merits of the various Qualitative Tests for Nickel and Cobalt.*"

Di. J. F. Ewan (Hygienic Laboratory) exhibited a collection of the various salts obtained in the extraction of cobalt and nickel from the manganiferous ores of New Caledonia. These ores, containing the metals in the form of oxides, are extensively distributed over the island, and are also to be found on the continent of Australia. The amount of nickel and cobalt in various samples ranges from 1 up to 10 per cent. The process employed for obtaining the metals is that patented by M. Herrenschmidt, and is now being worked at Sydney, New South Wales.

Samuel Rideal, *Hon. Sec.*

NOTICES OF BOOKS.

Chemiker-Kalender (Chemist's Calendar), *for* 1885. By Dr. Rudolf Biedermann. Berlin, 1885: Julius Springer.

This excellent pocket-book, to which we have on several previous occasions drawn attention, and which has doubtless become well known and appreciated among our chemists, again makes its appearance for the coming year. The contents are much the same as in former editions, as well as the arrangement, a few extra tables having been added. The division of the calender into two parts is still maintained, one containing tables relating to purely chemical matters, such as analytical factors, solubilities, specific gravities, short descriptions of the commoner analytical methods, and a lengthy mineralogical table; the other part contains tables that will be especially useful to the physicist, bearing on barometry, thermometry, thermochemistry, expansion, electricity, magnetism, and such like. All the published data issued since the last edition of this work have been employed in correcting several of the tables, whilst the new matter that has been added relates to diffusion, capillarity, and galvanic batteries.

The division of such a handy pocket-book as the present one into two separate parts possibly has its advantages, but we think it would be just as useful and might perhaps be rendered more convenient if the two parts were bound together.

Second Annual Report of the Board of Control of the New York Agricultural Experiment Station for the Year 1883. With the Report of the Director and Officers. Albany: Weed, Parsons, and Co., 1884.

In this Report, which is somewhat late in appearing, little matter of chemical value is contained; such as it is consisting wholly of analytical results—no special chemical investigation bearing on agriculture being recorded. As regards the determination of nitrogen in fodder plants and such like materials, Dr. Babcock, the chemist of the Station, records a few comparative experiments made with the view to testing Kjeldahl's recently-described process for such determinations against the ordinary soda-lime method, and comes to the conclusion that the process is accurate and economical of time and gas, not to mention combustion-tubing.

In the botanical and horticultural reports a mass of heterogeneous data is given, from which the agriculturist may glean some interesting facts, perhaps more curious than of practical value; facts such as Darwin alone might have fully appreciated in compiling a work on botany to plead his theory.

In this, as well as in other countries, agricultural experimentation of a purely empirical character is yearly increasing, with its accompanying literature in the shape of reports. Such work as is undertaken in many cases appears to be utterly purposeless, or at most to support some pet theory, and consequently renders the squeezing out of the essence (if there be any) from these lengthy reports a most laborious process,—one, certainly, that few persons will be found inclined to undertake. If any real good is to be done by agricultural investigation it seems to us that the fewer words employed in describing the procedures the better, and that to each published investigation or report the conclusions that have been arrived at as the result of the experiments should be appended. By this means, although the theory or aim that started the investigation may not be grasped, the facts that were obtained will be made capable of apprehension.

CORRESPONDENCE.

COCOA-NUT OIL.

To the Editor of the Chemical News.

Sir,—I notice that cocoa-nut oil has been examined by the Koettstorfer process by E. Valenta (*Wagner Jahresberichte*, 1883, p. 1152), and A. H. Allen (*Ibid.*, p. 1157), but hope that my results, as given in the article dated Nov. 14, will be of interest as confirming and extending those obtained in the paper referred to.—I am, &c.,

Russell W. Moore.

John C. Green School of Science,
Princeton, N.J., U.S.A.

ATOMIC WEIGHT OF CERIUM.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. l., p. 251, there is a paper by Mr. Henry Robinson containing an account of a re-determination of the atomic weight of cerium. As there seems to be some doubt about the colour of ceric oxide, obtained by igniting the oxalate in air (Chemical News, vol. xlix., p. 282), it would be interesting to know whether the material employed by Mr. Robinson for his atomic weight determinations gave a yellow or a white oxide.—I am, &c.,

Samarium.

Formation of Anhydrides of Monobasic and Bibasic Acids.—R. Anschütz.—Many bibasic acids, if heated, give off water and pass into anhydrides, whilst most monobasic carbon acids distil unchanged. The author has especially studied the action of acetyl chloride upon the hydrates of certain bibasic acids. In the present paper he combines the results of previous experimentation on the formation of anhydrides by the action of acid chlorides upon hydrated acids.—*Liebig's Annalen.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—A degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 19. November 10, 1884.

Penetration of the Light of Day into the Water of the Lake of Geneva.—H. Fol and E. Sarasin.—The light penetrates into the water of the Lake of Geneva to a depth of 170 metres, and probably beyond. At this depth the strength of the light in the day is about equal to that which we perceive in a clear moonless night. At 120 metres the light is still tolerably strong. In September, in cloudy weather, the light penetrated more deeply and more abundantly into the water than in August under a clear sky.

A General Enunciation of the Laws of Chemical Equilibrium.—H. Le Chatelier.

The Polymorphism of Silicium Phosphate.—P. Hautefeuille and J. Margottet.—Silica dissolves abundantly in trihydrated phosphoric acid. To demonstrate this property it is merely requisite to throw into phosphoric acid, heated to above 120°, hydrated silica as obtained on decomposing silicium fluoride with water. Ignited silica does not dissolve more rapidly than in hydrofluoric acid. In chemical analyses great care must be taken not to heat silica in contact with phosphoric acid above 100°. Silicium phosphate, SiO_2PO_5, crystallises spontaneously in four crystallographic forms, mutually incompatible, and constituting four distinct chemical species: hexagonal crystals are formed below 300°, lamellæ resembling tridymite about 360°, regular octahedra between 700° and 800°, and clinorhombic prisms between 800° and 1000°. This polymorphism cannot result from the grouping of identical crystalline elements, for the hexagonal crystals are attacked by water, whilst the octahedral and prismatic crystals resist its action.

The Action of Primary Alcoholic Iodides upon Silver Fulminate.—G. Calmels.—The author has succeeded in methylating silver fulminate. He finds that this body consists of two dissymetric portions, each containing silver. He views the fulminates as metallic isocyanides or carbilamines joined by nitrogen to a diatomic residue of metallic nitromethane.

Hydrate of Neutral Aluminium Sulphate.—P. Marguerite Delacharlonny.—The author gives instructions for the preparation of this salt which, if kept from contact with the air, contains 27 mols. water, but losses 11 of them on free exposure.

Saponification of simple Aromatic Ethers by Neutral Bodies.—A. Colson.—On examining the action of water the author finds that the limit of saponification is reached more rapidily than with the fatty ethers. As regards the simple ethers derived from the xylenic glycols, the limit is the same for the three isomers, and probably for all the homologous ethers. The rapidity of saponification alone distinguishes the three isomeres from each other. Alcohols attack the ethers of the aromatic series with rapidity at 100°, and very sensibly even at common temperatures. The alcohols ROH reacting upon the aromatic bromides give complex reactions, due, probably, to their dissymetric constitution. They behave like true mixed bases, exchanging sometimes the group OH and sometimes the group RO.

Researches on Saccharogeny in the Beet-root.—Aimé Girard.—The author traces the origin of betose in the plant and its emigration towards the root.

The Peptonic Fermentation.—V. Marcano.—The name peptonic fermentation has been given to the transformation of albumenoids into peptones by the vital action of microbia. The author added a few drops of the juice of the *Agave* to minced meat, covered with water and placed in a flask, which was then placed in a stove at 35° to 40°. An active fermentation set in, with liberation of inodorous gases: thirty-six hours afterwards the fibrine had disappeared, leaving a liquid charged with peptone, which, when dried in the stove, represented 20 per cent of the weight of the meat employed. The author proved by further experiments that this action is due to a figured ferment. Among the products of the reaction are lactic acid and a trace of alcohol. The author suggests that this process may be applied for exporting meat in a far more nutritive and economical form than the extracts of meat.

No. 20, November 17, 1884.

Experimental Demonstration of the Electromotive Force from the Contact of Iron and Copper at Elevated Temperatures.—F. F. Le Roux.—At the temperature of 1000° a current proceeding from the copper to the iron heats the point of junction, but refrigerates it at ordinary temperatures.

On the Rain-Waters of the City of Algiers.—M. Chairy.—The author has sought for ammoniacal salts in rain-water. In two cases he has found little or no ammonium nitrate, but has easily ascertained the presence of nitrite, even when operating upon so small a quantity as half a litre. Iodine has never been discovered. Hydrogen peroxide has been repeatedly sought for by Schœne's method, but with a negative result.

On Combustible Compounds of Carbon existing in the Atmosphere.—A. Muntz and E. Aubin.—The authors show that hydrogen carbides are poured into the atmosphere from a variety of sources. They prove that such gases, even when in minimum quantities, are decomposed by electric discharges with formation of carbonic acid.

On Arsenic Trifluoride.—H. Moissan.—If this compound is heated in presence of silica there is no deposit of arsenic, this body being entirely converted into arsenious acid.

Reaction of Ferric Oxide at High Temperatures upon certain Sulphates.—M. Scheurer-Kestner.—If a mixture of 2 parts calcium sulphate and 1 part ferric oxide is ignited to strong redness, all the sulphur of the mixture is expelled. There remains a melted mass, soluble even in weak acids, and insoluble ferric oxide. The result is similar with other diatomic metals. The sulphur is given off at first in the state of sulphuric anhydride, but afterwards as sulphurous acid and oxygen.

On the Ammoniacal Ferment.—A. Ladureau.—By ammoniacal ferment the author means that which transforms urea into ammonium carbonate. It exists in considerable quantities in the soil, in the atmosphere, in the waters on the surface of the earth, in rain, and in many underground waters. It acts as well in a barometric vacuum as at the normal pressure or even under a pressure of 3 atmospheres. It decomposes urea in presence of air, of oxygen, nitrogen, hydrogen, carbonic oxide, and nitrogen monoxide. With the exception of chloroform, which delays its action, anæsthetics have no effect upon it. Antiseptics do not interfere with its action, except when used in very large quantities.

The Presence of Amylase in Leaves.—L. Brasse.—The author finds amylase constantly present in all the leaves which he has examined, and in several seeds.

Justus Liebig's Annalen der Chemie, Vol. 225, Part 1.

Communications from the Chemical Institute of Marburg.—These consist of a memoir, by Th. Zincke and A. Breuer, on a Hydrocarbon, $C_{16}H_{12}$, from Styrolene

Alcohol; a paper, by Th. Zincke and A. Hedebrand, on the Action of the Quinones upon the Amido-phenols; and an Account of the Carbonic Ethers of Bivalent Alcohols and Phenols, by M. Wallach.

Communications from the Principal Chemical Laboratory of the University of Tübingen.—These include an illustrated memoir, by Lother Meyer and Karl Seubert, on Gas-analysis at greatly-reduced pressure, and a paper by Lother Meyer on the Calculation of Gas-analyses.

The Substitution of an Atom of Oxygen for Two Atoms of Chlorine in Chlorides, by means of Oxalic Acid.—R. Anschütz.—By means of dehydrated oxalic acid the author obtains the corresponding aldehyds from the chlorides of the monobasic and bibasic carbon acids; the aromatic aldehyds from the aromatic aldehyd chlorides and the aromatic acid chlorides; and the corresponding anhydrides from the aromatic ortho-acid chlorides.

Cosmos les Mondes.
No. 10, November 15, 1884.

The Liquefaction of Gases.—Dr. D. Tommasi.—The author has come upon the following passage in the *Antologia di G. P. Viesseux* (vol. xxvii., A.D. 1827):—"Perkins has submitted water and other liquids to powerful pressure, employing a bronze cylinder in which worked a steel piston. The cylinder was 34 inches in length; its internal diameter is 1¼ and its external diameter 13¼ inches. The greatest pressure exerted by means of this apparatus was 2000 atmospheres. Compressed air in contact with mercury began to be liquefied at 500 atmospheres; at 1000 atmospheres the mercury filled two-thirds of the space previously occupied by the air, and small liquid drops began to appear. At 1200 atmospheres there was seen over the mercury a transparent liquid occupying 1-2000 of the space previously taken up by air. Ethylen began to be liquefied at 40 atmospheres, and at 1200 it was entirely reduced to a liquid." Dr. Tommasi raises the question whether the air operated on by Perkins was absolutely dry?

MISCELLANEOUS

The Recognition of Atropine.—Dr. O. Schweissinger.—Some time ago A. W. Gerrard published a memoir on the behavious of atropine with mercuric chloride. Unlike all other alkaloids it gives a red precipitate, whilst most other alkaloids give a white precipitate, codeine and morphine a pale yellow, and strychnine and caffeine none. Schweissinger has repeated Gerard's experiments. He finds that arbutine, condurangine, and sparteine give no precipitates, cocaine a white and scoparine a yellow precipitate. The behaviour of hyoscyamine and homatropine is especially interesting. If 1 m.g. of hyoscyamine (as Gerrard proposes) was covered with 2 c.c. of the reagent (5 per cent mercuric chloride dissolved in alcohol at 50 per cent) the red precipitate did not appear. If the hyoscyamine was only moistened with 1 or 2 drops of the solution and gently heated, the red precipitate appeared exactly as with atropine, and was not affected by the further addition of the mercuric solution. Homatropine gives no red precipitate, but a yellowish white one in very strong solutions.—*Chemiker Zeitung.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Copper Matte.—A corespondent in the United States wishes to know of some responsible buyers of copper matte, carrying gold and silver.

Calcined Magnesia.—As a constant reader of your journal I should be glad if you could inform me of the best method to manufacture "calcined magnesia" from the original stone. Also the description of plant needed for the manufacture.—N. C. WRIGHTSON.

To Replace Coal-Gas.—Being so unfavourably situated as to be unable to have the advantages resulting from the use of coal-gas, I would be much obliged to any of our readers if they could inform me how to construct a furnace suitable for heating, say, 1 to 5 grms. of iron to the melting-point by means of petroleum, or any other cheap liquid fuel, with or without bellows power.—T. CHARLTON.

MEETINGS FOR THE WEEK

MONDAY, Dec. 8th.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures.) "The Use of Coal-Gas," by Harold B. Dixon, M.A.
—— London Institution, 5.
TUESDAY, 9th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
WEDNESDAY, 10th.—Society of Arts, 8. "The Preparation of Butterine," by Anton Jurgens.
—— Microscopical, 8.
THURSDAY, 11th.—Royal, 4.30.
—— Society of Arts, 8. (Howard Lectures.) "The Conversion of Heat into Useful Work," by W. Anderson, M.Inst. C.E.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— London Institution, 5 and 7.
FRIDAY, 12th.—Astronomical, 8.
—— Quekett Microscopical Club, 8.
SATURDAY, 13th.—Physical, 3. "On the Effect of an Electrical Current on the Thinning of a Liquid Film," by Prof. A. W. Reinold, F.R.S., and Prof. A. W. Rücker, F.R.S. "On a Theory of the Molecular Architecture of Solids, illustrated by a Wire Vibrating Torsionally," by Herbert Tomlinson.

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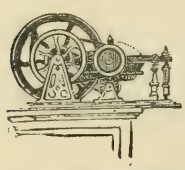

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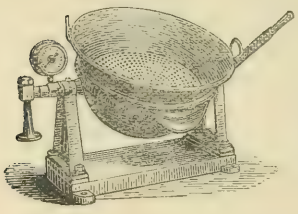

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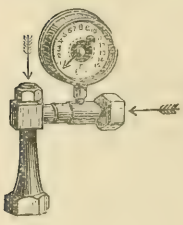

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THE CHEMICAL NEWS.

Vol. L. No. 1307.

ON JAPANESE CAMPHOR OIL.

By H. OISHI.

Laurus Camphora, or Kusu-no-Ki, grows in Japan mainly in those provinces in the islands Shikoku and Kiushiu, which have the southern sea coast. It also grows in Kishiu.

The amount of camphor varies according to the age of the tree. That of a hundred years old is pretty rich in camphor.

In order to extract this such a kind of the tree is selected, and its trunk, stems, &c., are cut into small pieces and introduced into a wooden tub, A, having a false bottom. This tub stands over an iron pan containing water, which is heated by a furnace, C, below, as represented in the figure. The steam arising from the pan passes into the tub, where it meets with the cut pieces of the wood, and carries the vapours of camphor and oil together into a condenser, *a*, by means of a bamboo pipe. Here all the camphor and oil, together with steam, are condensed, while the uncondensed portion of steam escapes into the air through a pipe attached to the corner of the condenser. The latter is made of a wooden trough which is surrounded by another one, *b*, filled with cold water. In order to expose a large surface to perfect condensation of the vapours, the condensing trough is fitted internally with a number of vertical partitions which are open at alternate ends, so that the vapours may travel along the partitions in the trough from one end to the other.

The continual supply of water is made by a pipe from which it flows into a wooden trough, *c*, placed just over the condenser. From the upper trough the water flows into the lower one, *b*, thus keeping the condenser cool all the time.

One operation requires about 20 hours. After that time the contents of the tube is withdrawn, dried, and used as fuel. A new charge is then introduced from the top of the tub, after which it is well closed and the distillation is again commenced.

To supply the water into the pan, it is better introduced from the top of the tub, before the charge is taken out; by this means the water in passing down through a heated layer of the wood becomes itself heated, and thus shortens the time of heating in the pan.

As the distillation begins, a semi-solid mixture of the camphor and oil generally accumulates between the partitions in the trough, floating above the condensed water. The camphor and oil thus accumulated in the trough are taken out after several charges, usually 5 to 10 days. The quantity of the yield varies greatly in different seasons. The solid camphor is obtained much more in winter than in summer, while the amount of the oil is just reverse. In summer time, from one charge consisting of 120 kilos. of the wood, 2·4 kilos. of the camphor are obtained in one day, while in winter from the same amount, 3 kilos. of solid camphor can be obtained in the same time.

In summer, from the semi-solid mixture obtained during 10 days, 18·04 litres of the oil are obtained, while in winter only 5 to 7 litres are obtained.

The oil, which contains in solution a considerable quantity of camphor, was formerly regarded as useless, but three years ago a method was devised which consists in distilling the oil and cooling the distillate. The arrangement of the apparatus is as shown in the figure.

The crude oil is introduced into iron kettles, *a*, *a'*. Each of them is provided with a stopper having two holes; one is for inserting the delivery tube, and the other is for introducing the crude oil during the operation. The vapour passing through spiral tubes made of brass, and kept cool by water, is condensed and the oil is received into suitable vessels, which, when full, are taken away and cooled by surrounding with a fresh quantity of cold water. By this means the camphor separates out as a semi-solid mass, and in order to separate the solid camphor from the oil, the liquid is filtered or squeezed out through a cloth bag. The oil thus separated still contains a certain quantity of solid camphor. In order to remove this it is again mixed with a fresh quantity of the oil and distilled as before. In this way 173 kilos. of the crude oil yields 36 to 45 kilos. of solid camphor; thereby the volume of the original oil becomes about a half. The purified oil, or that which is freed from the camphor, is used as a lighting material by the lower people of the province.

The purified camphor oil is a colourless liquid and burns with a bright smoky flame; the general properties resemble very much those of the solid camphor. Crude oil has specific gravity 0·959 and the purified oil has 0·895 at 15° C. By oxidation in the air, or by nitric acid, or by oxygen, a change in the composition occurs, and it produces ordinary camphor together with certain higher oxyhydrocarbons, and the oil gradually becomes yellow. The oil dissolves many resins, such as gum-mastic, gum eleui, colophonium, &c.; it dissolves asphaltum, sulphur, and mady other things.

Reactions with acids:—

Hydrochloric acid separates the oil into two layers, the upper one being transparent, the lower one is turbid. Nitric acid separates the oil also into two layers, the upper being yellow and the lower being colourless, but on heating it becomes a reddish liquid, which after some time again separates into two layers, but the oil suffers oxidation. When sulphuric acid is added, the oil is dehydrated, leaving a liquid smelling like terpene; when added in a large quantity, the oil is charred.

When chlorine is passed slowly into the oil, it is absorbed with elevation of temperature and evolution of hydrochloric acid fumes; the oil is thus changed into a yellow liquid. When excess of chlorine is passed, the oil becomes viscous. This semi-solid substance does not smell like camphor oil. With bromine the same reactions are produced, and when excess of bromine is added a red amorphous substance is formed. The oil dissolves a large quantity of iodine, and when heated becomes dark red. This dark red liquid when cooled below 0° C. becomes a semi-solid mass.

The specific rotatory power of the oil was examined by Sohil's saccharimeter and was found to be 68·96°, while the calculated value for $[\alpha]j$ is 68·29°.

To separate the oils of different boiling-points, the original camphor oil was subjected to fractional distillation. The following is the result of distillation, using 200 c.c. of the oil.

Temp. of Distil.	Vols.
35 to 150° C.	12·0 c.c.
150 to 155	5·5
155 to 160	3·6
160 to 162	9·0
162 to 164	7·3
164 to 166	6·0
166 to 168	6·9
168 to 170	10·0
170 to 172	13·6
172 to 174	14·5
174 to 176	21·8
176 to 178	12·7
178 to 180	12·7
180 to 182	9·0
182 to 184	11·8
184 to 186	5·0
186 to 188	4·0
188 to 190	3·6
190 to 198	4·5
Residue	25·0
Total	188·5
Loss	1·5

All the distillates afford nearly the same reactions with the reagents.

The analysis of the distillate between 180° to 185° gave following result :—

C	78·87
H	10·73
O	10·40 by difference.

The composition thus nearly agrees with that of ordinary camphor.

After repeated distillations he gave the following analysis of the fraction between (178 to 180)[3] :—

$$C = 86{\cdot}95 \text{ and } H = 12{\cdot}28.$$

Thus it is a hydrocarbon.

(Exponent 3 means that the distillation was done three times). The vapour density of the hydrocarbon was found to be 5·7; its molecular weight is therefore 164·4. We have then the necessary data to ascertain its molecular formula :—

$$\frac{164{\cdot}4 \times 12{\cdot}28}{100} = 20{\cdot}18 = H_{20}$$

$$\frac{164{\cdot}4 \times 86{\cdot}95}{100} = 11{\cdot}91 = C_{12}.$$

The formula is therefore $C_{12}H_{20}$; thus it is a hydrocarbon of the terebene series, having the general formula C_nH_{2n-4}.

The appended table will show clearly the nature of different distillates and resemblance of the oil to the ordinary camphor.

From these experiments it appears that the camphor oil is a complicated mixture consisting of hydrocarbons of terpene series, oxy-hydrocarbon isomeric with camphor, and other oxidised hydrocarbons.

The distinguishing property of the camphor oil, that it dissolves many resins and mixes with drying oils, finds its new application as solvent for varnish. He tried in various ways with different resins and drying oils, and obtained rather a satisfactory result,

1. When colophonium, liquid balsam, gum elemi, or gum mastic is respectively melted in a porcelain dish and mixed with camphor oil, stirring all the time, each of them completely dissolves, and, when cooled, a heavy liquid is obtained, which may be used as a varnish. In applying this as a varnish it should be slightly warmed. This varnish, when spread over foreign paper and slightly warmed makes the paper very transparent. Japanese paper soaked in the same also becomes very bright and transparent.

2. When a little turpentine oil is mixed with the resin solution in the oil, the varnish dries much more quickly and assumes a brighter surface. The turpentine oil should be added after the resin is dissolved in the oil.

After various trials the following mixture was found to be the best :—

Camphor oil	10 grms.
Turpentine oil..	3·3 „
Resin	8·0 „

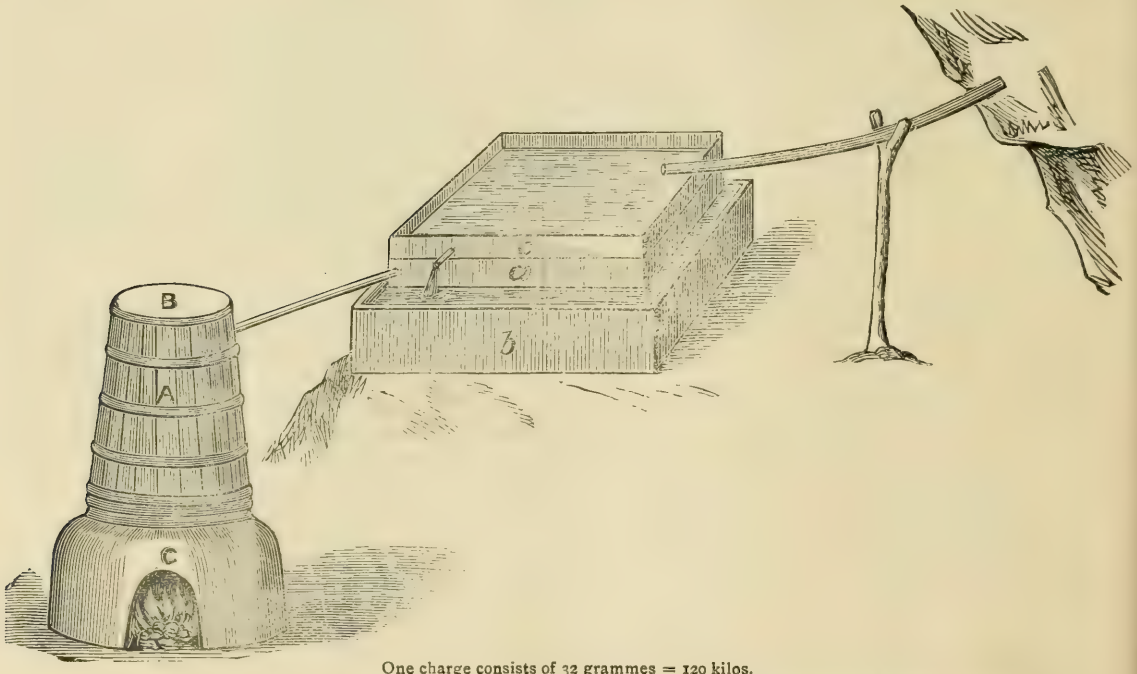
3. When mixed with linseed oil the same result as above is obtained, but this varnish does not dry so quickly as the second one, so that the varnished object requires slight warming in order to dry it completely.

4. Since the camphor oil dissolves dragon's blood, gamboge, the varnish may be coloured red or yellow. Little alcoholic solution of aniline-red, purple, and blue were respectively mixed with the resin solution and coated on paper, and on drying in sunshine the first two colours disappeared, but the last remained as a fine blue.

5. When camphor oil is added to melted asphaltum, stirring all the time, a good varnish is obtained, which, when coated upon metallic surface and dried, produces very fine bright surface just like Japanese urushi. The best proportion is 22 grms. of oil to 5 grms. of the asphaltum.

6. The mixture of camphor oil with linseed oil or rapeseed oil produces a kind of varnish, which when coated upon paper makes it water-proof. The best water-proof paper is obtained by using the solution of aluminium palmitate in camphor oil.

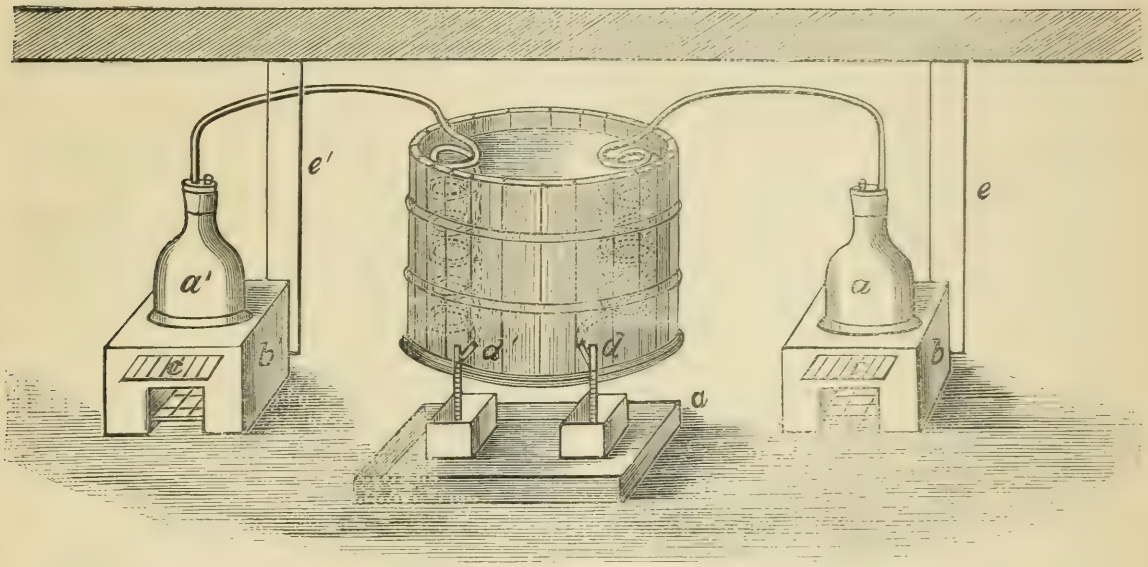
FIG. 1.



One charge consists of 32 grammes = 120 kilos.
Boiler, 3 shaku in diameter. Wooden tub, 2·8 shaku in lower diameter and 1·5 in the upper, and 4 shaku in height.

Fractions.	Alcohol required to dissolve 1 part of the Oil.	Specific Gravity at 15° C.	[a] of the Chloroform Sol. containing 25 p.c. of the Oil.	Vapour Density.	Percentage composition.	Formulæ deduced.
(45 to 156° C.)	10·0	0·8655	66·02	—	—	—
156 160	9·0	0·8397	—	—	—	—
160 162	8·0	0·8400	66·02	5·29	—	$C_{11}H_{18}$ (?)
162 164	8·0	0·8580	—	—	—	—
164 166	7·4	0·8575	—	—	—	—
166 168	6·9	0·8525	—	—	—	—
168 170	6·1	0·8556	66·66	—	—	—
170 172	5·4	0·8615	—	—	—	—
172 174	4·4	0·8586	—	—	—	—
174 176	3·9	0·8636	—	—	—	—
176 178	2·8	0·8650	66·02	—	—	—
178 180	0·8	0·8745	72·51	5·70	C = 86·95 H = 12·28	$C_{12}H_{20}$
180 185	0·5	0·9260	—	—	C = 78·87 H = 10·73 O = 10·40	$C_{10}H_{16}O$
220 230	—	—	—	—	C = 78·20 H = 9·25	—
250 260	—	—	—	—	—	—

FIG. 2.



First, the paper was coated with a thin solution of the palmitate; this, after being dried, is again coated with more concentrated solution and dried; when the third coating is done the paper becomes stronger, and capable of resisting the action of water for more than thirty-five hours.

Soot has somewhat an extensive application, being used for making inks, paintings, and colouring walls, &c. The soot obtained from the camphor oil is one of the best qualities, and is used for making the best kind of our solid ink. It is therefore important to see how much soot can be obtained from a certain definite quantity of the oil, and whether it can be got profitably or not. The first method consisted simply in burning the oil and putting a cold metallic plate over the flame and collecting the soot deposited: by this means 7·5 grms. were obtained from 100 c.c. of the oil. When presenting this black to a certain dealer, the author was informed that the soot under question is next to the best quality, and that its price may be 35 cents per 375 grms.: the quantity of the oil required to produce it is 5 litres, calculated from the experimental result, and the price of 5 litres of the oil is 27·8 cents.

In the second experiment the oil was burnt in the same way, but within a metallic cylinder, whose bottom has many holes for admission of air. From 100 c.c. of the oil 13 grms. were obtained; therefore, only 3 litres of the oil are necessary to obtain 375 grms.

Three litres of the oil cost 16·7 cents, and produce 375 grms., costing 35 cents; thus there is an excess of 18 cents over the cost of the oil required. From this it may be said that the soot can be profitably prepared from the camphor oil.

The following is the report on the amount of annual production in Tosa:—

10th Year of Meiji (1877).

Amount of camphor produced .. 504,000 kins.
The total cost.. .. .. 65,520 yens.

11th Year of Meiji (1878).

Amount of camphor produced .. 519,000 kins.
The total cost.. .. .. 72,660 yens.

12th Year of Meiji (1879).

Amount of camphor produced .. 292,890 kins.
The total cost.. .. .. 74,481 yens.

13th Year of Meiji (1880).

Amount of camphor produced .. 192,837 kins.
The total cost.. .. .. 58,302 yens.

NOTE ON THE ESTIMATION OF ANTIMONY.

By GEORGE T. DOUGHERTY,
Chemist and Assayer Chicago Smelting and Refining Company.

In smelting-works like ours, the chemist is frequently called upon in the course of his work to determine antimony in ores, hard leads, antimony slags, and other products or by-products of the smelting and refining process. Great accuracy in the assay of this metal is attainable only by resort to a complete chemical analysis, which, as all of us know, takes quite a long time. The management usually cares for quick and approximately correct returns on antimony.

The method that will best answer these desiderata for the present is to be done half in the fire, and afterward completed with wet or chemical agents. Where the substance tested is an oxide, we may reduce the metals together into a button by means of charcoal or red argol. If there is any sulphur present, it would be better to dispense with the common method of reduction with argol and iron wire, but instead, to decompose with a mixture of equal parts of potassium cyanide and sodium carbonate. The button of lead and antimony thus produced will be clean and free from lumps of iron matte, which are often very difficult to remove by hammering without losing particles of the brittle alloy.

If assayed for lead and antimony, the button may be weighed, and after hammering thin or cutting into small pieces, put into a small porcelain dish; nitric acid (diluted with its volume of water) is poured over it, and is allowed to boil down with no replenishing of acid until very shallow, when the alloy will have been completely decomposed. All the lead goes into solution, while the antimony is converted into a white precipitate, which, after diluting the solution, may be filtered, dried, ignited, and weighed as antimony tetroxide (Sb_2O_4). The difference between the weight of the button and that of antimony in that button gives the amount of lead. If the button has been too impure, the lead may be determined in the filtrate from the antimonic acid as a sulphate. Ten grms. is a most convenient quantity to work on in assaying for those metals by this method.

It has been no easy matter to many of us before in attempting to cut up such alloy in solution quickly. One of the standard works on assaying, which is high in authority, and has always enjoyed deference of opinion among men of our profession, directs the use of "concentrated" nitric acid for dissolving. I have repeatedly tried with it; but it always has a very slow action on buttons of a similar composition, even when boiling, and taxes our patience heavily; for it takes not hours but good days to finish its prescribed work. With weaker acid (half acid and half water) the button can be separated completely within thirty or forty-five minutes.—*Engineering and Mining Journal.*

National Association of Science and Art Teachers.—At the first meeting of the new Executive Council of this Association held in Manchester on Saturday, November 29th, Dr. H. C. Sorby, F.R.S., in the chair, Sir Henry E. Roscoe, F.R.S., &c., was elected President. Steps were taken to largely extend the Association, and it was decided to hold the next meeting of the Council in Birmingham, early in February.

NOTE ON THE ESTIMATION OF IRON BY POTASSIC PERMANGANATE IN PRESENCE OF FREE HYDRIC CHLORIDE AND CHLORIDES.

By JOHN J. HOOD, D.Sc., Assoc. Royal School of Mines.

The estimation of iron by means of permanganate in solutions containing free hydric chloride is well known to be unreliable, owing to the action of this acid on the permanganate, and partly to the objectionable yellow colour acquired by the solution masking the final point in the titration.

In the course of some preliminary experiments on the rate of oxidation of ferrous chloride in presence of other chlorides towards a classification of chemical substances on a dynamical basis depending on their retardation effects, it was necessary to determine accurately the permanganate equivalent of the iron in such solutions to within 0·03 c.c. in 10 c.c. of the permanganate. It was found that in attempting to apply a correction for the error introduced by a constant amount of hydric chloride the presence of many soluble chlorides likewise produces an appreciable error in such estimations. In attempting to get over the difficulty a simple device was hit upon, one possibly employed by others, by means of which the estimation of iron in solutions containing hydric chloride or chlorides may be made as reliable as is the case when hydric sulphate is the acid employed and no chlorides in solution; at least in solution of such strength as indicated below, which, however, are somewhat more dilute than are usually employed. The device consisted in the addition of a few c.c. of a strong solution of magnesic sulphate,—from 1 to 2 grms. according to the amount of hydric chloride or other chloride present—to the iron solution before titration. By this means, probably ferric sulphate and not chloride being formed, the solution scarcely acquires any more perceptible colour than when ferrous sulphate in titrated, and the final point in the titration is well shows by the pure pink colour of the solution.

In the following results magnesic sulphatewas employed, although a few comparative experiments made with ammonic sulphate gave equally good results. Other soluble sulphates, however, might also be found equally efficient, but magnesic sulphate was selected owing to its great solubility, low molecular weight, and great retarding effect on the oxidation experiments referred to.

The solution contained 0·7 grm. iron as chloride in 250 c.c.; of this 10 c.c. were employed for each determination, equal to 0·028 grm. Fe.

The burette used was one of 10 c.c. capacity, on which 0·02 c.c. could be read. The results, although given in cubic centimetres, are only approximately so, being in reality expressed in the unit employed in calibrating the instrument.

By means of a solution of ferrous sulphate and one of potassic bichromate it was found that 10 c.c. of the above ferrous chloride solution should require 9·41 c.c. of the permanganate employed, and the following results were obtained under the different conditions :—

	C.c. $KMnO_4$.
10 c.c. $FeCl_2$ solution—	
+0·1 grm. free HCl	required 9·54
,, +1 grm. $MgSO_4$	9·43
+0·2 grm. free HCl	9·55
,, +1 grm. $MgSO_4$	9·44
+0·3 grm. free HCl	9·55
,, +1 grm. $MgSO_4$	9·43
+0·5 grm. free HCl	9·57
,, +1 grm. $MgSO_4$	9·46
+1 grm. free HCl	9·65
,, +2 grms. $MgSO_4$	9·48

In presence of chlorides similar results were obtained.

Two solutions were made, each containing 0·7 grm. of the same iron wire, in one case dissolved in hydric sulphate and in the other in 3 grms. hydric chloride. 10 c.c.

of the ferrous sulphate required of the permanganate 9·29 c.c., whilst 10 c.c. of the chloride solution gave the following numbers :—

		C.c. $KMnO_4$.
10 c.c. $FeCl_2$ sol.	required	9·42
Ditto, +1 grm. $MgSO_4$		9·31
Ditto, +0·5 grm. AmCl		9·62
Ditto, ,, ,,	+1 grm. $MgSO_4$	9·33
Ditto, +0·5 grm. $MgCl_2$		9·45
Ditto, ,, ,,	+1 grm. $MgSO_4$	9·34
Ditto, +0·5 grm. $BaCl_2$		9·47
Ditto, ,, ,,	+1 grm. $MgSO_4$	9·31
Ditto, +0·5 grm. $ZnCl_2$		9·51
Ditto, ,, ,,	+1 grm. $MgSO_4$	9·34
Ditto, +0·5 grm. $CaCl_2$		9·46
Ditto, ,, ,,	+1 $MgSO_4$	9·33

When baric chloride was employed the precipitate formed by the addition of the sulphate seemed to carry down some of the iron, and unless a little care was taken the results were liable to be slightly too low.

A few experiments were made by varying the amount of chloride up to 1 grm. (with 0·28 grm. Fe). Of the salts tried ammonic chloride produced the greatest discrepancy, increasing with the amount of salt added, the depth of yellow colour of the solution also increasing. The addition of magnesic sulphate prevented almost wholly the formation of this colour, and gave practically the normal reading for the permanganate.

THE ESTIMATION OF ALKALIES IN SILICATES.*

By THOMAS M. CHATARD.

Walter Hempel proposed (*Fres. Zschr.*, 1881, p. 496) bismuth subnitrate as a means of decomposing silicates containing alkalies, and recommended the use of 20 parts of this salt (=10 parts of bismuth oxide) to one part of the silicate. In the *Berichte d. D. Chem. Gesellsch.*, 1881, there is an abstract of his paper, in which is proposed the use of bismuth oxide directly.

This process has been in use in this laboratory for the past six months, and, with some modifications, has given great satisfaction. Bismuth oxide has been used instead of the subnitrate, and experience has shown that, instead of 10 parts, as stated above, *two parts* of oxide to *one part* of the mineral are ample in every case in which we have employed the method.

The oxide and mineral, both finely powdered, must be thoroughly mixed, and then heated in a platinum crucible; applying at first a gentle heat and gradually increasing to full redness, which is kept up ten to fifteen minutes. In the case of an acid silicate, complete fusion may result, while the more basic the silicate the less fusible the mixture will be. Complete decomposition has been obtained when the resulting mass was so slightly sintered together as to fall on gentle pressure into powder, none of which adhere to the crucible. It has therefore been found advantageous, in dealing with acid silicates, to add to the mixture a quantity of calcium carbonate, in weight equal to that of the mineral. This device prevents the fusion which might hinder the after treatment with acid.

After the mass has been thoroughly heated to bright redness it is allowed to cool, placed in a dish, and hydrochloric acid somewhat diluted poured over it. On heating over the water-bath the mass should go into solution rapidly, leaving no residue of undecomposed mineral, which is easily distinguishable from floating flakes of silica.

If complete analysis is required, evaporate to dryness and separate the silica, as in a soda fusion, afterwards removing the bismuth by sulphuretted hydrogen. If only alkalies are to be determined, add ammonia and ammonium carbonate, filter, and separate magnesia from the alkalies by any of the usual methods.

The results of this process have been very satisfactory. Out of a large number of analyses the following duplicate has been selected as being sufficient to show the accuracy of the work. It may be remarked that in the case of this margarite (a very basic silicate) the mass was but slightly sintered together.

Margarite.—Gainesville, Ga.

1·0300 grms. gave 0·0440 alkali chlorides = 0·0233 Na_2O = 2·26 per cent.

1·0243 grms. gave 0·0435 alkali chlorides = 0·0231 Na_2O = 2·25 per cent.

* From the *Bulletin of the United States Geological Survey*, No. 9.

THE OCCURRENCE OF AMMONIA, NITROUS ACID, AND NITRIC ACID IN POTABLE WATERS.

By M. GREINERT.

The natural formation of nitrites and nitrates is explained by a more or less complete oxidation of the ammoniacal compounds formed by the decomposition of animal matter. The case that ammonia or ammoniacal salts are present, unaccompanied by more highly oxidised compounds, is frequent. Occasionally there are found along with ammoniacal compounds, nitrates without the slightest trace of nitrites. In some cases nitrous acid is detected, whilst it is impossible to establish the presence of ammonia and nitric acid. The examination of 126 waters containing nitrogenous compounds gave the following result:—Ammonia alone, 21; nitrous acid alone, 6; nitric acid alone, 35; nitrous and nitric acid, 15; nitrous acid and ammonia, 13; nitric acid and ammonia, 17; nitrous and nitric acids with ammonia, 19. Hence it appears that nitric acid alone was the most frequent impurity in the wells under examination and in the third rank nitric and nitrous acids along with ammonia. Nitric acid with ammonia was more common than nitrous acid with ammonia. Nitrous acid alone was the rarest. The theory of the gradual conversion of ammonia into nitric acid is well known. But it does not explain why nitrous acid alone should be present, for the natural assumption is that those ammoniacal strata of water which come in contact with the atmosphere begin to take up oxygen and gradually transfer it to the lower strata. Ammonia should therefore always be detected along with nitrous acid, which in certain cases did not hold good. The theory, further, does not explain the striking phenomenon that ammoniacal compounds may be present along with nitrates, but without the slightest trace of a nitrite. —*Chemiker Zeitung and Pharm. Zeitung.*

COULOMB'S EXPERIMENTS.

A TEXT-BOOK CORRECTION.

By JOSEPH M. STOCKS.

Many books state that in Coulomb's experiments with his torsion balance—the results of which experiments are given as proving that magnetic repulsions vary inversely as the square of the distance—"he found that the moveable disc at the top had to be turned 35° in order to move the needle 1°; that is, the earth's magnetic action was equal to a torsion of the wire corresponding to 35°." But there is evidently only a torsion corresponding to 34°; because the top disc has only moved 35°, and the needle has *followed* it 1°, so that 35°−1°=34°, the true angle of torsion.

"The torsion being proportional to the angle of torsion"

the action of the earth corresponds to a torsion of 34° (and not 35°) for each 1° the needle moves away from the meridian.

This correction reduces the experimental error of Coulomb's experiment by 75 per cent, or rather by 125 per cent, because when, "by inserting a magnet, he repelled the needle through 24°," the repulsive force (R) between the two, being balanced by the torsion of the wire, aided by the earth's action—

$$R=24°+(24\times34°)=816,$$

and not, as is usually given,

$$24°+(24\times35°)=864.$$

When, turning the upper disc eight times round, he brought the needle back to 12°, where the repulsive force is balanced by the torsion (produced by the needle turning the bottom end of the wire 12° in one direction, and the upper end of the wire being turned eight times round in the opposite direction), aided by the earth's action, from which—

$$R=12°+(8\times360°)+(12\times34)=3300,$$

and not, as generally given,

$$12°+(8\times360°)+(12\times35°)=3312$$
$$4\times864=3456$$
$$3312$$
$$\text{Error } 144$$
$$3300$$
$$4\times816=3264$$
$$\text{Error after correction } 36$$

THE

COMPOSITION AND METHODS OF ANALYSIS OF HUMAN MILK.*

By Prof. ALBERT R. LEEDS, Ph.D.

(Continued from p. 267).

History of Samples Analysed.

THE mother's diet in every instance was simple, but abundant and nutritious. Only normal milks were analysed, such as came from healthy women; these presented, when submitted to the microscope, a normal appearance.

The physical history of mothers and infants is given in the original memoir, in Table I. (here omitted).

COMPARISON OF FINAL RESULTS WITH PREVIOUS ANALYSES.

Analyses of Eighty Samples of Woman's Milk.

Reaction uniformly alkaline.

	Average.	Minimum.	Maximum.
I. Specific gravity	1·0313	1·0260	1·0353
II. Albumenoids	1·995	0·85	4·86
III. Sugar	6·936	5·40	7·92
IV. Fat	4·131	2·11	6·89
V. Solids not fat	9·137	6·57	12·09
VI. Ash	0·201	0·13	0·37
VII. Total solids (by addition of constituents)	13·268	10·92	16·79
VIII. Total solids (directly by evaporation)	13·267	10·91	16·66
IX. Difference between VII. and VIII.	0·001	0·00	0·21
X. Water	86·732	83·21	89·08

The most interesting comparison which can be made is that with the results given by König (*Chemie der Mensch. Nahrungs und Genussmittel*), which are deduced from the analyses of 190 samples. These analyses, it should be remembered, were performed according to the most diverse methods, errors in opposite directions operating to mutually compensate one another.

Analyses of samples of woman's milk (König) :—

	Average.	Maximum.	Minimum.
Albumenoids	1·94	0·57	4·25
Sugar	6·04	4·11	7·80
Fat	3·90	1·71	7·60
Ash	0·49	0·14	1·78(?)
Water	87·09	83·69	90·90

As might be anticipated, the extremes are wider apart than in my own analyses, but the general mean of all, with the exception of the ash, is tolerably concordant.

Omitting particular reference to the results of Fernois and Becquerel and earlier investigations, I will quote further only the results of Gerber (mean of six analyses), Christenn and Marchand (*Beilstein's Handb. der Organ. Chem.*, 2081).

	Gerber.	Christenn.	Marchand
Albumenoids	1·8	1·9	1·7
Sugar	5·4	6·0	7·1
Fat	5·3	4·3	3·7
Solids not fat	7·2	8·2	9·0
Ash	0·4	0·3	0·2
Total solids by evaporation	10·9	12·8	12·7
Water	89·1	87·2	87·3

Bidert (*loc. cit.*) found the albumenoids to vary, in the samples which he analysed, between 1·5—2·4 per cent; fat, between 3·8 to 4·4 per cent. His mean for albumenoids is 1·95; my own is 1·995; König's is 1·94 per cent.

Two per cent., therefore, may be regarded, without sensible error, as *the average amount of albumenoids in woman's milk.*

The more extended series of eighty analyses confirm, however, the statements made in my earlier paper (that on Infant Foods), the albumenoids being the most variable constitutent of woman's milk, the fat the next most variable, and the sugar the least. Nor have I any reason to alter the interpretationtherein given of the physiological signification of the greater and less variability of the individual constituents.

Relations between the Physical History of the Milk and its Composition.

The only relations which I shall attempt to discuss here are those appertaining to the—

1st. Colour, taste, consistency, and specific gravity.
2nd. Age of the mother.
3rd. Period of lactation, and interval since nursing.
4th. Nationality.
5th. Physical constitution of the mother.

I. *Colour, Taste, &c.*—Whether bluish-white, chalky-white, whitish, yellowish-white, or yellow, the colour is no indication of the composition. For example, the milk of a German brunette, taken one hour after previous nursing and during the tenth day of lactation, was chalky-white in colour, whilst it contained 6·89 per cent of fat. This was the largest percentage of fat in any sample. On the other hand, though many of the yellow samples were rich in fat, other yellow samples were very poor. Thus, No. 8 was yellow (the milk being drawn during the fourth day of lactation, and four and one-half hours after nursing), while it contained only 2·31 per cent of fat,

Taste.—Although the amount of sugar in woman's milk is large, being nearly 7 per cent or 2 per cent more than in cow's milk, it is rarely sweet to the taste. Usually, it has a more less saline, somewhat disagreeable animal flavour.

Consistency.—Although the amount of solids in woman's milk is decidedly greater than in cow's milk, its consistency is much thinner and more watery.

* Read by invitation, before the College of Physicians of Philadelphia, May 7th, 1884, and reprinted by permission from advance-sheets of its Transactions.

Specific Gravity.—The average is somewhat greater than in cow's milk, though the entire range of variation is not very different. Thus, in the 80 samples examined, the average specific gravity is 1 0313, the minimum 1·026, the maximum 1·0353. Conrad obtained in 130 observations for the two last figures 1·025, and 1·039. In 147 samples of normal cow's milk L. Jenke found 1·0245 for the minimum, 1·034 for the maximum, and 1·0297 for the mean.

II. *Age of Mother*.—The milk of women under the age of 20 is richer in each and every constituent than that of older women. The general average of *albumenoids* for the first lustrum is 2·18 per cent, while it is only 1·92 per cent for the second, and 2·10 for the third. The difference is still more striking in regard to sugar. In the first lustrum the sugar is 7·17 per cent, falling to 6·91 in the second lustrum, and in the third only 6·77 per cent. This falling off is notable, not only in the percentages, but in the number of samples which exceed the average. Thus, in the first lustrum, 83 per cent of the whole number of samples exceed the general average in sugar, while in the second lustrum only 60 per cent exceed. A similar diminution is observable in the fat and total solids.

(To be continued).

TABLE II.—ANALYSES OF 80 SAMPLES OF HUMAN MILK.

Number on blank.	Laboratory number	Color.	Spec. grav.	Albuminoids.	Milk-sugar.	Fat.	Solids not fat.	Ash.	Total solids by addition of constituents.	Total solids directly by evaporation.	Difference.
1	1021	Yellow	1.0321	1.44	7.20	5.58	8.81	0.17	14 39	14.46	—0.07
2	1022	.....	1.0351	1.68	7.53	3.55	9.42	0.21	12 97	12.84	+0.07
3	1023	White	1.0353	1.96	7.31	4.62	9.45	0.18	14.07	13.96	+0.11
4	1024	.....	1.0346	1.73	7.25	2.95	9.19	0.18	12.11	11.96	+0.15
5	1025	White	1.030	1.49	7.23	2.12	8.90	0.18	11.02	11.11	—0.09
6	1026	Yw.-white	1.030	1.45	7.24	3.20	8.93	0.24	12.13	12.10	+0.03
7	1027	Yellow	1.034	3.12	6.47	5.49	9.91	0.32	15.40	15.35	+0.05
8	1028	Yellow	1.030	2.15	6.51	2.31	8.94	0.28	11.25	11.40	—0.15
9	1029	....	1.032	2.05	7.08	3.00	9.26	0.13	12 26	12.31	—0.05
10	1030	.....	1.030	1.43	7.19	2.11	8 81	0.19	10.92	10.91	+0.01
11	1031	.....	1.031	1.98	6.99	3.06	9.17	0.20	12.23	12.21	+0.02
12	1032	.....	1.031	1.76	6.97	2.44	8.93	0.20	11.37	11.40	—0.03
13	1033	.....	1.030	2.40	6.45	6.01	9.07	0 22	15.08	15.07	+0.01
14	1034	.....	1.032	2.52	6.44	4.95	9.23	0.27	14 18	14.16	+0.02
15	1035	.....	1.032	2.18	6.75	2.84	9.06	0.13	11.90	11.88	+0.02
16	1036	Yellow	1.030	0.85	5.50	6.16	6.57	0.22	12.73	12.73	0.00
17	1037	Yellow	1.034	1.49	7.37	5.02	9.03	0.17	14.05	14.18	—0.13
18	1038	Dull-white	1.033	3.95	7.92	4.37	12.09	0.22	16.46	16.55	—0.09
19	1039	.....	....	....	....	....	....	0.15	.....	12.34	....
20	1040	.....	....	....	....	....	....	0.30	.....	14 08	....
21	1041	.....	....	....	....	....	....	0.22	.....	13.01	....
22	1042	.....	....	....	....	....	....	0.21	.....	12.74	....
23	1043	.....	1.030	2.10	6.61	4.02	8.91	0.20	12.93	12.88	+0.05
24	1044	.....	1 030	1.94	7.45	3.61	9.56	0.16	13 17	13.02	+0.15
25	1045	.... .	1.032	2.16	7.00	5.84	9.38	0.22	15.22	15.18	+0.04
26	1046	.....	1.030	2.08	6.98	3.28	9.26	0.20	12.54	12.39	+0.15
27	1047	.....	1.031	1.98	7.00	2.44	9.19	0.21	11.63	11.84	—0.21
28	1048	White	1 031	2.23	7.39	2.95	9.83	0.21	12.78	12 95	—0.17
29	1049	White	1.030	1.81	6.88	2.80	8.89	0.20	11 69	11.70	—0.01
30	1050	Yw.-white	1.031	2.11	7.41	5.04	9.72	0.20	14.76	14.69	+0.07
31	1051	Chalky-white	1.033	2.27	6.75	5.96	9.17	0.15	15.13	15.21	—0.08
32	1052	Yw.-white	1.030	1.53	5.84	5.62	7.21	0.14	12.83	12.99	—0.16
33	1053	Yellow	1.030	2.24	6.25	2.76	8.84	0.35	11.60	11.45	+0.15
34	1054	Chalky-white	1.034	2.19	7.46	6.89	9.90	0.25	16.79	16.66	+0.13
35	1056	White	1.032	2.43	7.34	3.13	9.98	0.21	13.11	13.20	—0.09
36	1057	Yellow	1.031	2.43	7.23	3.79	9.88	0.22	13.67	13.63	+0.04
37	1058	Chalky-white	1.032	1.60	7.55	6.21	9.37	0.22	15 58	15.45	+0.13
38	1064	White	1.021	1.82	6.96	3.97	8.97	0.19	12.94	12.87	+0.07
39	1065	Yw.-white	1.030	2.33	5.78	4.21	8.32	0.21	12.53	12.57	—0.04
40	1066	Yellow	1.032	1.75	6.94	3.68	8.97	0.28	12.65	12.52	+0.13
41	1067	White	1.031	2.45	6.08	3.82	8.72	0.19	12.54	12.41	+0 13
42	1055	White	1.031	1.97	7.38	4.16	9.60	0.25	13.76	13.60	+0.16
43	1059	Chalky-white	1.031	1.50	7.32	3.77	9.00	0.18	12.77	12.64	+0.13
44	1060	White	1.030	1.49	7.31	4.34	9.01	0.21	13.35	13.17	+0.18
45	1061	Yw.-white	1.031	2.33	7.48	2.47	9.97	0.16	12 44	12.36	+0.08
46	1062	White	1.031	1.35	7.24	4.09	8.89	0.31	12.98	13.15	—0.17
47	1063	Yellow	1.032	4.86	5.40	3.36	9.46	0.20	13.82	13.35	+0.47
48	1068	Yw.-white	1.032	1.93	6.95	5.59	9.06	0.18	14.65	14.58	+0.07
49	1069	White	1.031	2.00	6.95	4.64	9.16	0.21	13.80	13.74	+0.06
50	1070	White	1.031	2.06	6.39	4.75	8.62	0.22	13.44	13.48	—0.04
51	1071	Yellow	1.030	2.42	6.95	5.60	9.56	0.19	15.16	15.25	—0.09
52	1072	White	1.030	2.15	6.76	6.78	9.07	0.16	15.85	15.89	—0.04
53	1073	White	1.029	1.82	6.83	4.28	9.02	0.37	13.30	13.30	0.00
54	1074	Yw.-white	1.030	1.50	7.34	3.10	8.92	0.18	12.02	12.12	—0.10
55	1075	White	1.026	2.43	6.57	4.94	9.27	0.27	14.21	14.20	+0.01
56–59	1133	.....	1.0297	1.16	7.41	4.74	8.78	0.21	13.57	13.63	—0.06
60–63	1134	.....	1.0296	1.95	7.02	3.85	9.19	0.22	13.04	13.12	—0.08
64	1135	.....	1.0312	2.00	6.69	3.96	9.01	0.32	12.97	13.05	—0.08
65	1137	.....	1.0319	2.25	7.12	5.85	9.52	0.15	15.37	15.35	+0.02
66	1138	.....	1.0307	1.11	7.07	2.73	8.40	0.22	11.13	11.13	0.00
67	1139	.....	1.0322	1.96	7.28	4.74	9.54	0.30	14.28	14.28	0.00
68	1140	.....	1.0317	2.17	7.44	4.36	9.90	0.29	14.26	14.26	0.00
Robust	6 cases	.....	1.031	1.44	6.94	3.71	8.63	0.25	12.34	12.37	—0.03
Anæmic	6 cases	.....	1.031	2.12	6.74	3.96	9.02	0.22	13.10	13.08	+0.02
Maximum		.....	1.0353	4.86	7.92	6.89	12.09	0.37	16.79	16.66	0.21
Minimum		.....	1.0260	0.85	5.40	2.11	6.57	0.13	10.92	10.91	0.00
Average		.....	1.0313	1.995	6.936	4.131	9.137	0.201	13.268	13.267	0.001

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, December 4, 1884.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. L. Clarke, J. N. Collie, A. E. Dixon, G. Embrey, G. S. Jones, F. Rindskopf, H. White.

Mr. S. U. Pickering then read a paper "*On Calorimetric Determinations of Magnesium Sulphate.*" The heat of dissolution of monohydrated magnesium sulphate is given by Graham as 13,200 cals., by Favre as 10,986, and by Thomsen as 13,300. None give any details of the preparation or analyses of the salt which they used. The author found it impossible to determine the sulphur by means of barium chloride with the requisite accuracy; the sulphur trioxide was found to be 1 to 1·5 per cent too high. The only reliable method for ascertaining the composition of any magnesium sulphate is a determination of the water. When the hepta-hydrated salt is heated to 100° to 130° it retains about $1\frac{1}{6}$ H_2O. This excess of one-ninth H_2O may be expelled by heating to 150° to 160°, but if this temperature be exceeded, some anhydrous salt will be formed. As a mean result the author finds that $MgSO_4H_2O+420H_2O$ evolves 12131 cals. Favre's salt probably contained $1\frac{1}{3}H_2O$: Thomsen's specimen, on the other hand, may have contained some anhydrous salt. The anhydrous salt, $MgSO_4+420H_2O$ evolves 20765 cals.

Mr. Howard confirmed the statement of Mr. Pickering as to the very great difficulty of determining the sulphuric acid in magnesium sulphate by precipitation with barium chloride.

Dr. Japp then read a paper "*On Condensation Compounds of Benzil with Ethyl Alcohol,*" by Miss M. E. Owens and F. R. Japp. In preparing benzylic acid by heating benzil with alcoholic potash Jena observed the formation of a neutral compound fusing at 200°, to which he gave the formula $C_{14}H_{12}O_2$. Limpricht and Schwanert obtained the same body by heating benzoin and alcoholic potash with access of air, and concluded that it was a derivative of benzoin and had the formula $C_{30}H_{26}O_4$. The authors of the present paper, by the protracted action of very dilute alcoholic potash upon benzil in the cold, have prepared this substance in large quantity, the yield being 60 per cent. The analyses lead to the formula $C_{30}H_{24}O_4$. Its formation may be represented—

$$2C_{14}H_{10}O+C_2H_6O=C_{30}H_{24}O_4+H_2O.$$

10 grms. of caustic potash were dissolved in 2500 c.c. of alcohol, and 200 grms. of benzil in fine powder added. The whole was well shaken, and allowed to stand for about a fortnight, with occasional shaking. The new body gradually separates out as a crystalline powder. The substance after purification fused at 200° to 201°. It crystallises from alcohol with a molecule of alcohol of crystallisation, which seems to have been overlooked by Limpricht and Schwanert. When crystallised from benzene it also contains benzene of crystallisation. When heated with acetic acid a compound of the condensation product with acetic acid is obtained, but no true acetyl derivative could be prepared either by the action of acetic anhydride or acetyl chloride. A second condensation product was found in the mother-liquors, fusing at 232°, and having the formula $C_{46}H_{34}O_4$. The authors have also examined the action of dilute alcoholic potash on benzoin, and promise an account of it in a future paper.

The Secretary then read a "*Note on the Solubility of certain Salts in Fused Nitrate of Soda,*" by F. B. Guthrie. The author has experimented with the sulphates, chromates, and carbonates of barium, strontium, calcium, and lead. The salts are added in small quantities to the fused nitrate of soda with stirring. The whole was allowed to cool, and after partial solidification the remaining liquid was poured out and analysed. The chief results obtained are solubility of barium sulphate, 2·6 per cent; barium chromate, 0·205; barium carbonate, 0·916. The strontium salts taken in the same order gave 1·845, 2·133, and 0·69; calcium salts, 1·477, 0·547, 0·294; lead salts, 6·82, 0·245. Lead carbonate decomposed at the temperature of fusing nitrate of soda.

The following paper was also read by the Secretary:—"*On certain Derivatives of Isodinaphthyl,*" by A. Staub and Watson Smith. In a former paper it was suggested that "by gentle oxidation of the dinaphthyls the corresponding isomeric naphthoic acids may be obtained." The authors, however, find that isodinaphthyl is not amenable to gentle oxidation. Strong nitric acid in the cold gives a nitro-body; dilute nitric acid in sealed tubes forms phthalic acid; potassium permanganate also gave phthalic acid. Chromic acid in glacial acetic acid, however, produced isodinaphthyl quinone, $C_{20}H_{10}O_4$, a yellow amorphous powder, melting with decomposition at 250° to 260°. By the action of strong nitric acid on isodinaphthyl a tetra-nitro body, $C_{20}H_{10}(NO_2)_4$, was obtained as an amorphous brownish yellow powder, melting with decomposition at about 150°. By the action of zinc-dust a tetramido body was formed. In conclusion, the authors give a list of the compounds of this remarkably stable dinaphthyl which have been obtained.

The Society then adjourned to December 18, when a ballot for the election of Fellows will be held.

UNIVERSITY COLLEGE, LONDON,

Chemical and Physical Society.

Thursday, December 4, 1884.

C. E. Cassal, F.I.C., F.C.S., President, in the Chair.

The Annual Address was delivered by Prof. T. G. Bonney M.A., D.Sc., F.R.S., on "*Serpentine Rock and its Origin.*' The lecture was illustrated by Wright and Newton's new oxy-hydrogen microscope.

After the lecture a Conversazione took place in connection with University College Society. Exhibitions of scientific apparatus and chemical compounds were shown in the Library and Chemical and Physical Laboratories. During the evening demonstrations were given by Mr. Rose Innes, B.Sc., on "Radiant Matter;" by Mr. C. A. Schunck, on "Absorption Spectra;" and by Mr. E. E. Graves, F.C.S., on "Ozone."

The meeting was well attended.

Samuel Rideal, *Hon. Sec.*

OBITUARY.

THE LATE PROFESSOR KOLBE.

On the evening of Tuesday, November 25th, this distinguished chemist came suddenly to his end. He had experienced no premonitory symptoms, and had, on the day of his death, been at work in his laboratory up to 5 p.m. He then went to a meeting, from which he returned about 8 p.m. and fell dead at the door of his house. An autopsy showed that fatty degeneration of the heart had been in progress for some time.

Adolf Wilhelm Hermann Kolbe was born in 1818 at Elliehausen near Göttingen. He was educated at the Gymnasium and afterwards at the University of that town, where he studied chemistry under Wöhler from 1838 to 1842. During the three following years he was Bunsen's assistant at Marburg, and in 1846 he was co-assistant in

conjunction with Frankland in the laboratory of the Museum of Economic Geology in London, which was then under the management of Dr. (now Sir Lyon) Playfair. In 1847 he became editor of the *Dictionary of Chemistry*, (*Handwœrterbuch der Chemie*) published at Brunswick. In 1851 he was appointed Professor of Chemistry at Marburg, whence he was called in September, 1865, to the chemical chair of the University of Leipzig, which he filled with efficiency and honour up to his death. In 1869 he undertook the editorship of the *Journal f. Praktische Chemie*, founded by Otto Linné Erdmann. In this position he had latterly, as his colleague, Prof. E. von Meyer, by whom the Journal will doubtless be continued.

From an early date Kolbe took a meritorious part in the development of organic chemistry. His first researches appeared in *Liebig's Annalen*, and treated of the composition of the fusel oil of grain, the action of chlorine upon carbon disulphide, and the discovery of trichlor-methyl-hyposulphuric acid and methyl-hyposulphuric acid. In concert with Frankland he undertook an investigation on the conversion of cyanmethyl and cyanethyl into acetic and propionic acids. The results of these researches were communicated to the Chemical Society of London in 1847, and here we find the first enunciation of the view that the fatty acids and benzoic acid contain alcohol radicles in place of an atom of hydrogen in formic acid. Kolbe further developed this view and verified it experimentally. When Wurtz subsequently endeavoured to appropriate these discoveries Liebig emphatically upheld Kolbe's prior claim, concerning whom he said:—"His researches are all harmoniously connected, and are supported by theories which throw more light on the origin of the non-nitrogenous organic compounds than any others which organic chemistry possesses. In 1847 Kolbe proved that the compounds obtained from alcohols as cyanides of their radicles can be transformed into acids containing a proportion of carbon higher than that of the alcohol. In 1848 Kolbe, proceeding on his view that methyl is a component of acetic acid, represented the kakodyl compounds as dimethyl-arsenic derivatives. In the same year Kolbe and Frankland succeeded in isolating methyl (dimethyl), and in the following year the former chemist obtained methyl by the electrolysis of acetic acid. In 1850 he developed his views on conjugated radicles. In 1855 he showed the conversion of an acid into the corresponding aldehyd by means of the chloride and the cyanide. In 1860 he brought forward the view that certain compounds bear the same relation to carbonic acid as do others to the sulphuric. In the same year he discussed the natural connection of the organic and inorganic compounds. He regarded glycolic acid as oxy-acetic acid and glycocoll as amido-acetic acid, and interpreted rightly the composition of lactic acid and its relation to alanine. He recognised isethionic acid as oxy-ethyl-sulphonic acid and taurine as amido-ethyl-sulphonic acid. His methods of exact investigation enabled him to foresee the existence of the secondary alcohols and to apprehend the constitution of the di- and tri-carbon acids. Kolbe and Frankland must be indubitably recognised as the authors of the doctrine of the saturation-capacity of carbon—a doctrine which has been more fruitful than any other in the development of theoretical organic chemistry. He has also enlarged our knowledge of the acids of gum benzoin, of the chemical constitution of asparagine and asparagic acid; of the isomeric relations of fumaric and maleic acid, as well as of itaconic, citraconic, and mesaconic acid; of uric acid, of certain derivatives of cyamide, and the phosphorus compounds of platinum. His method for the industrial preparation of salicylic acid has rendered this substance widely available for sanitary and medical purposes.

We must not overlook another phase of Kolbe's activity. As a chemical critic he exerted a wholesome influence by exposing baseless, or at least undemonstrable, speculations. Vagueness and ambiguity of thought and expression in chemical memoirs and treatises he denounced without mercy. It need scarcely be added that by taking up this position (see the "Cemisch-kutischen Gänge," passim in the *Journal f. Praktische Chemie*) he isolated himself to a great degree from the less sober minded chemists of the day. It must be admitted that his critical writings occasionally at least bordered upon personalities. A singular but characteristic action was his rejection of the diploma of corresponding member of the Berlin Academy of Sciences, on the plea that he was too old to correspond with the Academy on scientific subjects.

Among his separate works are his "Manual of Organic Chemistry," in three volumes, (1854—1878); volumes iii. to v. of Graham Otto's "Manual of Chemistry,"; a "Short Text-book of Inorganic Chemistry (Brunswick, 1877), of which a second edition appeared this year, and of which a good English version has been recently brought out by Dr. Humpidge (Longmans and Co., 1884) and a corresponding "Text-book of Organic Chemistry," 1883. Nor must we forget his able satire "Aus der Molecular Welt."

His papers in the *Journal f. Praktische Chemie* cannot be here specified, but we may mention that his recent researches on isatine are said to promise, if not to present, "surprising results," and will be prosecuted by his assistants.

The greater part of the facts here given are taken from an article in the *Chemiker Zeitung* (*Cœthen*).

CORRESPONDENCE.

HEATS OF FORMATION OF ORGANIC COMPOUNDS.

To the Editor of the Chemical News.

SIR,—There appeared in the CHEMICAL NEWS, vol. I., p. 15, a communication from Dr. Ramsay on the "Heats of Formation of Organic Compounds calculated indirectly," and in a later number a letter from Mr. H. F. Morley briefly criticising the above paper.

As it appears to me that, in spite of Mr. Morley's lucid explanation, many young chemists and students might still be misled by Dr. Ramsay's views, I have allowed myself to write a few words on this important subject.

In the first place, the numbers $-27{,}820$ and $-27{,}830$, both of which Dr. Ramsay calls the "heats of formation of CH_2O_2 from its elements," *are not*, as Mr. Morley pointed out, the heats of formation of hydric formiate from its elements; and similarly, $-16{,}380$ and $+63{,}160$ *are not* the heats of formation of hydric acetate from its elements. That these numbers do not represent the formation heats of those compounds *from their elements* is apparent on mere inspection of the method in which Dr. Ramsay proceeds in his calculations, a method which he teaches us to adopt, not in preference over the ordinary way, but as the only true method of calculation.

He quotes Berthelot's calculation on the heat of formation of dipropargyl for showing some error in that calculation, but for my own part I am not able to find there any error, unless, of course, the experimental data are inexact.

Now, for calculating the heat of formation of an organic compound, we need make no assumption whatever as to the states in which carbon or hydrogen may exist in that particular compound. Let us, for example, calculate the formation heat of hydric acetate from its elements.

We start from an initial system consisting of C_2 (amorphous carbon) $+ H_4 + O_2$, and arrive at an identical final system consisting of $2CO_2 + 2H_2O$ (liquid) by two different processes.

(1) Suppose we combine together C_2, H_4, and O_2 to form hydric acetate; this would evolve or absorb a quantity of heat which we want to determine. Call this quantity x. Let us then burn $C_2H_4O_2$ into $2CO_2$ and $2H_2O$,

This, which represents the heat of combustion of hydric acetate, is found by experiment to be 210,300.

(2) Suppose we directly burn C_2 and H_4 into $2CO_2$ and $2H_2O$. This evolves, according to Julius Thomsen's data,—

$$2(C,O_2) = 2 \times 96,960 = 193,920$$
$$2(H_2,O) = 2 \times 68,360 = 136,720$$
$$330,640$$

Now, since starting from an identical initial system, we have arrived at an identical final system, the quantity of heat evolved during the first process must be equal to that evolved during the second. That is—

$$x + 210,300 = 330,640$$
whence $$x = 120,340$$

This number then represents the heat of formation of $C_2H_4O_2$ from *amorphous* carbon, gaseous hydrogen, and gaseous oxygen.

It may be observed that in this calculation we need not take into account the heat of vaporisation of amorphous carbon, because in both of the above processes we start from carbon in an equally solid state, so that the same factor entering into both sides of the equation of course cancels each other.

Dr. Ramsay seems to think that the only correct way of calculating the heat of formation of an organic compound is from "gaseous carbon," but I do not see any fault in stating the heat of formation from amorphous carbon or from diamond, as is indeed usually done.

In conclusion, I may point out that the heat of vaporisation of carbon is not exactly 39,780, as Dr. Ramsay states, even if we assume that "the heat of combustion of carbon supposed to be gaseous to form CO is identical with that evolved when CO burns to CO_2." And for this reason. When amorphous carbon burns to carbonic acid there is no gaseous condensation, but when carbonic oxide burns to carbonic acid there is a condensation from 3 volumes to 2, a process which evolves heat. We must take this into account, and consider the heat of combustion of carbonic oxide *under constant volume*, which is 68,370 − 290 = 68,080. Hence the heat of formation of carbonic oxide from amorphous carbon is 96,960 − 68,080 = 28,880, and the heat of vaporisation of amorphous carbon is, therefore, 68,080 − 28,880 = 39,200.—I am, &c.,

J. Sakurai,
Professor of Chemistry,
October 22, 1884. University of Tokio, Japan.

THE ATOMIC WEIGHT OF CERIUM.

To the Editor of the Chemical News.

Sir,—Will you allow me to state, in reply to "Samarium," that an answer to his question will be given in a future paper.—I am, &c.,

Henry Robinson.

Hardwicke Street, Newnham Croft,
Cambridge.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—A degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 21, November 24, 1884.

Experiments on Cocaine Hydrochlorate. — M. Vulpian.—These experiments relate solely to the physiological action of this compound.

Certain Reactions of Carbon Disulphide, and on its Solubility in Water.—G. Chancel and F. Parmentier.—If baryta-water is added to an aqueous solution of carbon disulphide the reaction at ordinary temperatures is scarcely appreciable. If heat is applied there is quickly formed a plentiful white precipitate of barium carbonate, whilst the supernatant liquid takes a fine yellow colour. In time the whole of the carbon present passes into the state of carbonic acid. This reaction is so definite that the authors found upon it a process for the quantitative determination of small quantities of carbon disulphide. The proportion of this compound dissolved in water sinks from 2 grms. per litre at 3·4° to 1·05 at 41·0°, and becomes *null* at the boiling-point of carbon disulphide. These experiments lead to the remarkable result that a solution of carbon disulphide in water behaves in a manner analogous to the solutions of gases which have no action on water.

The Action of Heat on Batteries, and on the Law of Kopp and Woestyne.—G. Lippmann.—The author establishes by a mathematical investigation that the battery elements which have a constant electromotive force are those which conform to the law of Kopp and Woestyne.

Dynamo-electric Machines: Experimental Confirmation of the two Reactions during Motion on the Effective Values of the Internal Resistance and of the Inducing Magnetism.—G. Cabanellas.—Not capable of useful abstraction.

Action of Water upon Double Salts.—F. M. Raoult.—The double salts which the author has studied are those containing more than one molecule of acid, and which may be regarded as formed by union of two simple salts of the same kind. He concludes that according as the lowering of the congelation-point of a double salt dissolved in water is equal or inferior to the sum of the partial lowerings of its simple constituent salts, we may decide whether the double salt is or is not entirely split up into its two components.

Composition of the Gaseous Products of the Combustion of Pyrites.—M. Scheurer-Kestner.—The deficiency of oxygen in the gases escaping represents the quantity of that gas which has been consumed by the sulphurous acid in its conversion into sulphuric acid. In fifteen determinations the author has found sulphuric anhydride absent in two cases only. The remaining thirteen gave results varying from 0·1 to 8·5 per cent.

Development in France of the Nematodes of the Beet-root during the Season 1884.—M. Aimé Girard.—The beets have been attacked by a parasite, *Heteredora schachtii*.

The Formation of Vegetable Acids in Combination with Potassa and Lime, of Nitrogenous Matters, and Potassium Nitrate in the Vegetation of Saccharine Plants.—H. Leplay.—Soluble potassium and calcium salts of the vegetable acids are distributed in all parts of the plant. There is a partial fixation of lime in insoluble combinations in the tissues, and an accumulation of the potassium salts of vegetable acids in the leaves.

Cosmos les Mondes.
No. 10, November 15, 1884.

A Congress of scientific societies is to be held at the Sorbonne during the year next ensuing. Among the physical questions to be discussed we find:—"Researches on the Presence of Watery Vapour in the Air by Astronomical and Spectroscopic Observations," and "What is the Utility of Magnetic and Electric Observations with reference to Weather-Prediction?"

A Forerunner of Pasteur.—Athanasius Kircher, in a work published in Rome in 1658, and entitled "Scrutinum Physico-medicum Contagiosæ Luis quæ Pestis dicitur," ascribes the Plague to the action of minute germs, or "animalcules."

No. 11, November 22, 1884.

Calculation of the Electromotive Force of Batteries.—Dr. Tommasi.—The figure for a Daniell's element obtained by means of electro-chemical equivalents is too great by 7·5 per cent, whilst that given by the method of thermic constants only exceeds the experimental result by 0·46 per cent.

No. 12, November 29, 1884.

This issue contains no chemical matter, except such as has been taken from other journals.

Moniteur Scientifique, Quesneville.
Vol. xiv., December, 1884.

On the Bark of Remijia purdieana and its Alkaloids.—O. Hesse.

On Quinine and Homoquinine.—O. Hesse.—These two papers are taken from *Liebig's Annalen*.

Review of Foreign Chemical Researches.—G. de Bechi.—This consists of a series of extracts from the *Berichte der Deutschen Chem. Gesellschaft*, comprising notes on a new method of forming anhydrides, by B. Lackowitz; on a new process for preparing nitriles, by G. Kruss; on the trimethylenic derivatives, by W. H. Perkin; the replacement of amidogen by chlorine in aromatic compounds, by T. Sandmeyer; the action of bromine aqua-regia upon organic compounds, by Brunner and Kraemer; the action of copper upon the chloro-derivatives of toluene in the chain, by M. Onufrowicz; on certain derivatives of ortho-amido-aceto-phenone, by A. Baeyer; on amido-aceto-phenone and its homologues, by P. Klingel; on thiophthalic anhydride, by Graebe and Zschokke; on the presence of diphenyl in the oil of coal-tar, by K. E. Schulze; on α- and β-methyl-naphthaline, by K. E. Schulze; the action of bibasic organic acids upon hydrazo-benzene, by E. Bandrowski; on dinitro-β-naphthol, by Graebe and Drews; on β-ethyl-naphthaline, by O. Brunel; on certain derivatives of naphthaline, by R. Flessa; on some derivatives of the naphthoic acid, by A. G. Eckstrand; the preparation of chlorine derivatives of anthracene and anthraquinone from tetra-chlorophthalic acid, by G. Kircher; on Laubenheimer's reaction, by E. Odernheimer; on the condensation-products of thiophene with the aldehyds, methylal, and benzylic alcohol.

Means Employed to render Photographic Surfaces more Sensitive for the Green, Yellow, and Red Rays.—H. W. Vogel.—In this memoir, which is taken from the *Berichte der Deutsch. Chem. Gesell.*, the author speaks of the substances which, when added to silver bromide, render it sensitive to all rays. He finds that one and the same colouring matter acts in very different manners upon different surfaces. Paris violet used with dry silver bromide collodion is as sensitive for the orange rays as for the blue, whilst with gelatino-bromide the sensitiveness for the orange rays is scarcely 1-50th of that for the blue rays. Moist collodion is still less favourable. Eosine behaves in an opposite manner; if a solution containing 1-400th of this colour is added to gelatino-bromide in the proportion of 2 per cent, the yellow of the spectrum has one-third of the sensibility of the blue. With dry collodion the yellow and the blue are equally sensitive to light, and moist collodion containing eosine is 8 to 10 times more sensitive for the yellow than for the blue.

Industrial Review and Patents.—A summary of English and German chemical patents along with a few technological notes.

Industrial Society of Mulhouse.—Meeting of October 8th, 1884.—M. Goppelsröder sent in two memoirs on the formation of oxy-cellulose and on that of persulpho-cyanogen by the electrolytic process. In the former paper he shows that if cotton is soaked in a solution of potassium or sodium nitrate, chloride, or chlorate, whether acid, neutral, or alkaline, placed upon 8 or 16 folds of moist tissue resting on a sheet of platinum which serves as the negative electrode, whilst there is placed above another sheet of platinum forming the possitive electrode, and the current is passed, the cloth is converted into oxy-cellulose in the parts touched by the positive electrode. In discharging Turkey reds or vat blues by the electrolytic process the cloth is weakened in the discharged parts by the formation of oxycellulose. In the second memoir the author describes the formation of persulpho-cyanogen by the electrolysis of a boiling solution of potassium sulpho-cyanide He shows that this body may be simultaneously formed and fixed electrolytically upon cloth, either white, or dyed a Turkey-red or a vat blue.

A. Scheurer described the power of the alkaline hypobromates of discharging indigo blues. Upon this colouring matter they act much more energetically than the corresponding hypo-chlorates. With certain other colours *e.g.* that of raw cotton, this is not the case.

Certain Reactions of Silver Cyanide.—C. L. Bloxam.—From the CHEMICAL NEWS.

Detection and Determination of Picric Acid.—G. Christel.—From the CHEMICAL NEWS and the *Zeitsch. fur Anal. Chemie.*

The Pungent Principles of Plants.—Dr. Thresh.—From the *Pharmaceutical Journal.*

Lectures on Fermentation.—Professor W.N. Hartley.—From the *Journal of the Society of Arts.*

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 8.

This issue contains no original memoirs.

Nos. 9 and 10.

Apparatus for the Rapid Determination of Oxygenated Water.—M. Martiknon.—The author's method cannot be described inteiligibly without the accompanying figures.

Justus Liebig's Annalen der Chemie,
Vol. 225, Part 2.

On the Carbon Acids of Synthetic Pyridic Bases.—R. Michael.—The author considers that the natural alkaloids may be regarded as complicated pyridine-derivatives. In this paper he examines collidine-dicarbon-etheric acid with its salts, collidine-dicarbon ether hydrochloric acid, collidine-monocarbonic ether, collidine-monocarbonic acid, collidine carbon hydrochloric acid, the oxidation-products of collidine-monocarbonic acid, such as lutidine-dicarbonic acid and its salts, picoline-tricarbonic acid, and pyridine-tetracarbonic acid.

Communications from the Principal Chemical Laboratory of the University of Tubingen.—These consist of an inaugural dissertation by R. Brix on the exchange of the halogens between organic and inorganic compounds, a paper on the same subject by B. Köhnlein, and a memoir on inorganic chlorides as transferrers of chlorine by A. G. Page.

Bark of Remijia Purdieana and its Alkaloids.—O. Hesse.—As the alkaloids present in this bark the author enumerates and describes cinchonine; cinchonamine with its salts, its behaviour with acetic anhydride, with nitric acid, with methyl-iodide and with ethyl-iodide; concusconine, its salts, its behaviour with methyl-iodide and the two series of derivatives thus obtained; chairamine and its salts; conchairamine, its salts and its behaviour with methyl-iodide; chairamidine and conchairamidine.

Physico-Chemical Notes.—Eilhard Wiedemann.—A reply to the criticisms of Schiff on the author's method of determining the change of volume in bodies during fusion.

MEETINGS FOR THE WEEK

SATURDAY, 13th.—Physical, 3. "On the Effect of an Electrical Current on the Thinning of a Liquid Film," by Prof. A. W. Reinold, F.R.S., and Prof. A. W. Rücker, F.R.S. "On a Theory of the Molecular Architecture of Solids, illustrated by a Wire Vibrating Torsionally," by Herbert Tomlinson.
MONDAY, Dec. 15th.—Medical, 8.30.
—— Society of Arts, 8. (Cantor Lectures.) "The Use of Coal-Gas," by Harold B. Dixon, M.A.
—— London Institution, 5.
TUESDAY, 16th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 17th.—Society of Arts, 8. "The Present and Prospective Sources of the Timber Supplies of Great Britain," by P. L. Simmonds.
—— Geological, 8.
THURSDAY, 18th.—Royal, 4.30.
—— Chemical, 8. Ballot for the Election of Fellows.
—— Philosophical Club, 6.30.

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JOS. HERON,
Town Clerk.

Town Hall, Manchester,
3rd December, 1884.

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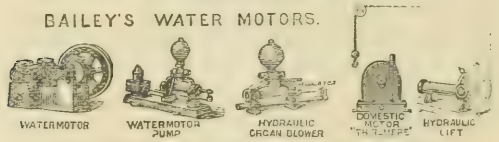

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A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

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Lord Salisbury's Clerk of Works writes:—"I am much pleased with the Water Motor, for it is most compact and useful."

From Messrs. Seed Brothers, Leather Merchants, Halifax:—"The Water Motor is doing its work well and quietly, and bids fair to answer our highest expectations."

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THE CHEMICAL NEWS.

Vol. L. No. 1308.

THE ABSORPTION-SPECTRA OF THE ALKALOIDS.*

By W. N. HARTLEY, F.R.S.,
Professor of Chemistry, Royal College of Science, Dublin.

While studying the molecular constitution of various organic substances by means of their action on the ultra-violet rays in the manner described in the *Philosophical Transactions*, vol. 170, 1879, it was considered of importance to ascertain whether absolute physical measurements could not be substituted for the uncertain chemical reactions and variable physiological tests at present employed as a means of detecting the alkaloids in medico-legal examinations. About forty alkaloids and derivatives therefrom have been examined, authentic specimens having been procured from the chemists by whom they were prepared. Solutions were carefully made of the same strength in most cases, only diactinic solvents, most generally alcohol, being employed. The cells with quartz sides for holding the solutions were of various thicknesses, ranging from 1 m.m. to 20 m.m. The electrodes employed to give a well-defined spectrum consisted, one of an alloy of tin with 20 per cent cadmium, the other of lead with cadmium in the same proportion. Spectra are thus obtained with lines of the same intensity, numerous and evenly distributed throughout a spectrum extending from wave-length 4414·5 to 2145·8. The prominent lines of cadmium are distinguished by their extension across the spectrum from pole to pole, while those of lead are on one side only and those of tin on the other. As a weaker continuous spectrum fills the intervals between the lines, there is no difficulty in obtaining accurate measurements. To secure well-defined spectra the photographs were taken with the solutions placed in front of the slit upon which the rays from the sparks were concentrated by a quartz lens of 2 inches diameter and 3 inches focal length. The spectra were measured by means of an ivory scale applied to the surface of the photographs; this had bevelled edges and was divided thereon into hundredths of an inch. The linear measurements are termed scale numbers and are arbitrary, but they were reduced to wave-lengths by the use of an interpolation curve. The oscillation frequencies were also read off on a second curve, whenever it was considered desirable to record them. The wave lengths were taken from those published in the *Philosophical Transactions*, p. 63, 1884, but for use in recording these measurements the fractions of a tenth-meter were disregarded. The total number of lines employed, including two or three air lines, was seventy.

The absorption curves which have been drawn differ from those figured in my previous communications, owing to the use of wave-length numbers, and the curves being made continuous, and so avoiding the necessity for shading; but very careful descriptions of the spectra are furnished in addition, so that no detail may be omitted. Nearly all the samples of alkaloids examined were obtained from Messrs. T. and H. Smith and Co., of Edinburgh, Mr. David Howard, of the firm of Howard and Sons, of Stratford, and Dr. C. R. A. Wright, F.R.S. The bodies may be divided into two groups, those which exhibit spectra with absorption-bands and those with continuous spectra.

* Abstract of a Paper read before the Royal Society, Dec. 11, 1884.

Alkaloids and Derivatives exhibiting Absorption-bands in their Spectra.

Aconitine	Tetracetyl morphine
Pseudaconitine	Diacetyl codeine
Japaconitine	Quinine
Morphine	Quinine sulphate
Narcotine	Cinchonine sulphate
Codeine	Quinidine sulphate
Thebaine	Cinchonidine sulphate
Papaverine	Veratrine
Oxynarcotine	Piperine
Apomorphine hydrochloride	Brucine
Cotarnine hydrobromide	Strychnine

Alkaloids yielding Continuous Spectra.

Narceine	Hyoscyamine
Aconitine (foreign)	Digitaline
Cevadine	Picrotoxine
Atropine	Nicotine
Solanine	Caffeine

The conclusions to be drawn from this investigation are the following:—

1. The absorption-spectra offer a ready and valuable means of ascertaining the purity of preparations of the alkaloids, and practically of establishing their identity.

The quantity of some of the alkaloids present in a solution may be estimated by means of the absorption-curves.

The different character of the various specimens known as aconitines may be recognised: thus the comparatively harmless base may be distinguished from those of great physiological activity by its transmission of a continuous spectrum, while the three specimens of physiologically active aconitines are distinguished from one another by their characteristic absorption curves.

That the three active aconitine bases are substances each with a different chemical constitution, is a conclusion confirmed by optical examination.

The purity of quinine and absence of any admixture of cinchonine can be readily determined by reason of the latter substance being much less diactinic than the former; but for the same reason quinine cannot be estimated in presence of cinchonine. Drugs of such potency as aconitine, morphine, quinine, strychnine, &c., which ought to be prescribed only when of absolute purity, should have their exact nature and degree of purity guaranteed by an examination of their absorption-spectra.

2. In comparing the spectra of substances of similar constitution it is observed that such as are derived from bases by the substitution of an alkyl radical for hydroxyl, the curve is not altered in character, but may vary in length when equal weights are examined. This is explained by the absorption-band being dependent upon the compactness of structure of the carbon and nitrogen nucleus of the molecule, and because equal weights are not molecular weights. Examples are afforded by morphine and codeine (methyl-morphine), diacetyl-codeine, and tetracetyl-morphine.

3. Bases which contain oxidised radicals, as hydroxyl, carboxyl, or methoxyl, diminish in diactinic quality in proportion to the amount of oxygen they contain. Examples are papaverine, narceine, narcotine, and oxynarcotine. The apo-derivatives are less diactinic than the parent bases in a degree which indicates that the molecular weights have been nearly doubled. Examples are apomorphia and pseud-aconitine.

4. Bodies with the pyridine and quinoline nucleus exhibit absorption-bands extending between wave-lengths 350 and 280, those with a benzene nucleus generally from 290 to 260, or rays even more refrangible; while the aconitines and opium bases, likewise strychnine, give evidence of a benzene nucleus, the cinchona bases, with piperine and brucine, appear to contain a nucleus of pyridine or quinoline.

CHEMICAL PHENOMENA OF THE RESPIRATION OF PLANTS.

(SECOND NOTE)

By Dr. T. L. PHIPSON, F.C.S., &c.

IN two previous communications to this journal I have studied the production of oxygen gas by *unicellular algæ*, and in the latter, which appeared a short time ago (CHEMICAL NEWS, vol. l., p. 37), the influence of *temperature* was merely referred to in a note, as I intended to treat of it more particularly in the present communication.

It is generally supposed that it is sufficient to expose the green parts of a plant to *light* to cause it to breathe, and that the so-called *actinic rays* which cause the combination of hydrogen and chlorine, and act upon the photographic plate, are the chief agents which bring about the evolution of oxygen gas by plant cells. I have found that *temperature* is also a most important agent, and that without a certain degree of heat no evolution of gas takes place.

It was Cloez and Gratiolet, however, who first drew attention to the fact that some water weeds only gave off oxygen gas when the thermometer stood at a certain height, but these observers did not compare the intensity of light on days of different temperatures as I have done.

On a day in November when the temperature was 38° F., the intensity of the daylight, measured photometrically, was about equal to what it was on a day of the previous September when the thermometer stood at 70° F.; yet on the first-named day the evolution of oxygen was *nil*, and on the latter very abundant. On the 14th January, the temperature outside my window being 45° F., little or no gas was evolved, in spite of the bright sunshine; but when the flask containing the plants was removed to the inside, where the thermometer stood at 59° F., some evolution of gas was apparent in about an hour.

I find that from 60° to 90° F. the respiration of unicellular algæ is extremely active in sunlight, and it appears evident that this process is intimately connected with the *circulation*.

The circulation in plants, as in animals, is much dependent upon temperature. A leaf of *Anacharis alsinastrum*, in which circulation is active, when pulled from the stalk exhibits a very feeble movement; the shock has the effect of checking, or altogether arresting, the movement of the green granules. But when I warm the glass slide to about 80° or 85° F., the circulation becomes as active as before.

It appears, therefore, that in plants, as in animals, the function of *respiration* is closely connected with *circulation*, and that *temperature* has quite as much to do with it as *light*.*

It was shown in my former note on this subject that the presence of *carbonic acid alone was not sufficient* to produce the evolution of oxygen gas by plants exposed to sunlight; that something else was required in the water in which they vegetate; for water which has been boiled for five minutes, then cooled and supplied with the requisite quantity of carbonic acid, gave no oxygen. It was pointed out that *peroxide of hydrogen* was the substance destroyed by boiling the water; and I hope soon to be able to publish some further observations on this important point.

In the meantime I wish to add a few words with regard to the *supposed production of oxygen gas* by infusoria, by the *Chlamidomonas pulvisculus*, *Euglena viridis*, &c., alluded to in the writings of Ch. Morren and of Justus von Liebig.

I have often observed that towards the end of May stagnant waters may be seen covered with a thin dark green film of oleaginous aspect, from which oxygen gas is given off most abundantly. On examining the composition of this film I find that it is formed, not of infusoria, but of *zoospores* in rapid motion. The motion continues for a few hours, after which the spores become fixed, and germination proceeds. There are certainly some minute infusoria also carried up to the surface of the water with these zoospores of the algæ, but they are easily distinguished by their *sarcode* and by a notable difference in their movements. The sarcode is seen to contract, whilst the membrane of the zoospore does not; the latter is solely moved by vibratil cilia, whilst the infusoria move by cilia and by the contraction of the sarcode. I am convinced that it is these zoospores (in which vegetation is extremely active, and which evolve oxygen in abundance) that have been mistaken for infusoria in the old observations alluded to, and that we have no evidence whatever that any infusoria, whether green or not, evolves oxygen gas in the sunlight.

Another point may be referred to here. It has been often thought that the *stomata* of leaves are essentially organs of respiration; but it is evident that they are by no means essential; for most of my observations have been made with unicellular algæ, in which these little organs do not exist.

A more important point is connected with the nature of *chlorophyll*. Some authors look upon chlorophyll as being intimately connected with the evolution of oxygen by plants in daylight. Several works state that the green parts only of plants act in this way. But not only do the cells of *Protococcus Pluvialis*, which are not brilliant green, but brownish or yellowish, emit oxygen like those of *P. palustris*, which have a dark emerald colour, but a curious observation which I have made seems to show that *the production of chlorophyll depends on the evolution of oxygen*, and not the evolution of oxygen on the chlorophyll.

Wishing to neutralise the carbonic acid in the water in which the unicellular algæ grew, I added a minute quantity of hydrate of soda, and found that in twenty-four hours the protococcus cells were bleached—the soda appears to have dissolved their chlorophyll—but were not killed. After being thoroughly washed in three waters for a day each time the plant was again exposed to sunlight. In about four hours oxygen began to be given off rather abundantly, and *next day* green specks began to be visible everywhere. It is natural to conclude that chlorophyll is formed under the influence of light, since we all know that plants placed in the dark are more or less bleached; but this experiment appears to show that the function of respiration in plants is independent of the chlorophyll; in other words, that the *chlorophyll is formed by the process of respiration*.

It has also been asserted by a German chemist that certain *organic acids* could replace carbonic acid in the respiration of plants. I have found, with regard to *tartaric*, *citric*, and *oxalic acids*, that this is not the case when these acids are introduced in place of their equivalent of CO_2 into the water surrounding the unicellular algæ.

When these organic acids are employed in exceedingly minute quantity they may set free a little CO_2 from the carbonates naturally present in the spring-water, and so give rise to a minute quantity of oxygen gas, which may thus appear to be derived from the organic acids. If, on the other hand, these organic acids are used in larger quantity they act as antiseptics, and put a stop to the functions of the plant altogether.

I conclude from this that *the organic acids cannot replace* CO_2 *in the process of respiration*; if they could do so it would be impossible that plants could contain any free acids.

As shown in my first note, it is probable that the *ternary compounds* in the plant cell are formed as the evolution of oxygen takes place. Hence the influence of both *light* and a certain *temperature* is necessary for the production of these compounds; and not only organic acids cannot

* It thus becomes evident that in making *actinometric observations* the apparatus used must account for *temperature* as well as for *light* (and probably for *moisture*) if the observations are to yield perfectly accurate results.

replace CO_2 in this process, but it is evident they must be formed from this CO_2, also that *sugar* is in its turn formed from them. I find that in grapes grown out of doors the production of sugar occurs first in the periphery, and gradually extends inwards as autumn advances, whilst the organic acids disappear. These remain to the last in the pulp around the seeds, where they act as antiseptics, until the moment arrives for the seed to fall and germinate. At this moment only is the greater portion of organic acid replaced around the seed by sugar.

A GENERAL ENUNCIATION OF THE LAWS OF CHEMICAL EQUILIBRIUM.

By H. Le CHATELIER.

Every system in a state of stable chemical equilibrium if submitted to the influence of an external cause which tends to modify either its temperature or its condensation, whether in its totality or only in some of its parts, must experience internal changes which, if they are produced alone, bring about a change of temperature or of condensation of a sign contrary to that resulting from the external cause. These modifications are generally progressive and partial. They are sudden and complete when they can be produced without any changing the individual condensation of the different homogeneous parts which constitute the system in equilibrium whilst nevertheless changing the condensation of the entire system. They are null when their production cannot bring on changes analogous to that due to the external cause. Lastly, if these modifications are possible they are not necessary. In the cases where they are not produced and where the system remains unaltered, the equilibrium becomes unstable, and can then only experience modifications tending to approximate it to conditions of stability.

As examples the author gives the following:—

1. Heating the totality of a system involves endothermic modifications such as fusion and volatilisation of all the bodies; polymerisation of C_2N, &c.,; reversible dimorphic transformations of AgCl, NH_4O, NO_3; dissociation of CO_2, CaO, CO_2, Bi_2O_3; reversible endothermic combination of CS_2 and very probably of NO_3; endothermic solution of most salts; endothermic crystallisation of such salts as sodium sulphate well known to decrease in solubility with the temperature.

2. The partial heating of a system involves changes all tending to cool the heated part, such as the propagation of heat by conduction, the production of thermo-electric currents, the changes of concentration by diffusion, the transfer of metals from one point to another of a plate immersed in a solution of one of its salts.

3. The increase of condensation of the totality of a system kept at a constant temperature brings on modifications which tend to diminish the condensation of the system, such as the fusion of ice, the solidification of paraffin, the dimorphic modification of AgI, the combination of the dissociated products of CO_2.

4. The increased condensation of a part of a system involves modifications tending to diminish the condensation of the part affected, such as the condensation of watery vapour, the combination of $CaO+CO_2$ at a red heat, the diffusion of solutions unequally concentrated, the transfer of metal on a plate plunged into a solution of one of its salts of variable concentration, reduction of the melting-point of an alloy or a mixture of metals during its progressive solidification.

5. Modifications of equilibrium are generally progressive: *e.g.*, in the dissociation of carbonic acid, and generally in all systems whose elements are not simply juxtaposed, but some of which form homogeneous mixtures among themselves.

6. Modifications of equilibrium are total when they may be produced without altering the condensation of each of the parts of the system, whilst still altering the condensation of its totality.

Such is the condensation of watery vapour, the fusion of ice, the dimorphic transformation of AgI, the dissociation of calcium carbonate, of solid copper oxide, the solution of salts. These systems on an infinitely small change of condensation in one of their parts pass from one extreme limit of their state of equilibrium to the extreme opposite limit.

7. The modifications of equilibrium are null when they cannot produce an effect analogous to that due to the external cause. Dissociation is independent of pressure for mixtures which combine without change of volume, *e.g.* hydriodic acid. The limit of equilibria is independent of the temperature when their transformations do not evolve heat, which is the case with etherification.

8. All these modifications of equilibria are merely possible and are not necessarily produced as is shown by superfusion, superheating, supersaturation, the sudden refrigeration of dissociated carbonic acid. The instable systems thus obtained can only be modified so as to approach the conditions of stable equilibrium. The transformation of these instable equilibria is generally effected with a liberation of heat, in conformity with the principle of maximum work, because, as M. van t'Hoff remarks, the ordinary temperature differs little from the absolute zero, for which the stable equilibrium corresponds to the liberation of the totality of heat contained in bodies.—*Comptes Rendus.*

THE COMPOSITION AND METHODS OF ANALYSIS OF HUMAN MILK.*

By Prof. ALBERT R. LEEDS, Ph.D.

(Continued from p. 281).

This research affords no adequate data as to the rate of decrease beyond the age of thirty years. The only complete analysis bearing upon this point is that of the milk of a dark-haired, black-eyed swarthy Pole, of gross habit and enormous breast development, who, at the age of thirty-three years, had been the mother of nine children. Two ounces were drawn from the right breast only, five hours after previous nursing. It was low in specific gravity, and yellow in colour. It contained—

Albumenoids	2·24
Sugar	6·25
Fat	2·76
Solids not fat	8·84
Ash	0·35
Total solids	11·45

III. *Period of Lactation, &c.*—If we divide this period into four intervals, the first extending from the beginning of lactation to the eleventh day after; the second from the eleventh to the thirty-first day; the third from the thirty-first to the ninety-first day; the fourth from the ninety-first day to the tenth month of lactation, we shall note the following changes:—

Albumenoids are greatest in the first intervals, being 2·32 per cent. In the second they exceed the general average, being 2·09 per cent. In the third interval they fall as much below the average as in the first they exceeded it, remaining at a low figure during the rest of lactation.

Sugar is least immediately after parturition and much below the average, whilst it is above and nearly constant during the three remaining periods.

* Read by invitation, before the College of Physicians of Philadelphia, May 7th, 1884, and reprinted by permission from advance-sheets of its Transactions.

TABLE III.—MILK OF WOMEN FKOM 15 TO 20 YEARS OF AGE. (First Lustrum.)

A = No. of cases above or below the general average.
B = Averages for A.
C = Averages for women from 15 to 20 years of age.
D = General averages for all years.

No. of sample.	Albuminoids.		Milk sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
	Above av.	Below av.	Above av.	Below av.	Ab. av.	Bel. av.	Above av.	Below av.	Above av.	Below av.	Above av.	Below av.
7	3.12	.....	.....	6.47	5.49	.....	9.91	.....	0.32	.....	15.35	
18	3.95	.....	7.92	.....	4.37	.....	12.09	.....	0.22	.....	16.55	
28	2.23	.....	7.39	.....	.....	2.95	9.83	.....	0.21	.....	.....	12.95
35	2.43	.....	7.34	.....	.....	3.13	9.98	.....	0.21	.....	.....	13.20
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.01
51	2.42	.....	6.95	.....	5.60	.....	9.56	.....	.....	0.19	15.25	
3	.....	1.96	7.31	.....	4.62	.....	9.45	.....	.....	0.18	13.96	
1	.....	1.44	7.20	.....	5.58	.....	.....	8.81	.....	0.17	14.46	
17	.....	1.49	7.37	.....	5.02	.....	.....	9.03	.....	0.17	14.18	
11	.....	1.98	6.99	.....	.....	3.06	9.17	.....	.....	0.20	.....	12.21
53	.....	1.82	.....	6.83	4.28	.....	.....	9.02	0.37	.....	13.30	
54	.....	1.50	7.34	.....	.....	3.10	.....	8.92	.....	0.18	.....	12.12
49	2.00	.....	6.95	.....	4.64	.....	9.16	.....	0.21	.....	13.74	
A	VI.	VI.	X.	II.	VIII	IV.	VIII.	IV.	VI.	VI.	VIII.	V.
B	2.70	1.69	7.27	6.65	4.95	3.06	9.89	8.94	0.26	0.18	14.60	12.29
C	2.18		7.17		4.32		9.58		0.22		13.87	
D	1.995		6.936		4.131		9.137		0.201		13.267	

TABLE IV.—MILK OF WOMEN FROM 20 TO 25 YEARS OF AGE. (Second Lustrum.)

A = No. of cases above or below the general average.
B = Averages for A.
C = Averages for women from 20 to 25 years of age.

No. of sample.	Albuminoids.		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
	Above av.	Below av.	Above av.	Below av.	Ab. av.	Bel. av.	Above av.	Below av.	Above av.	Below av.	Above av.	Below av.
38	.....	1.82	6.96	.....	.....	3.97	.....	8.97	.....	0.19	.....	12.87
15	2.18	.....	.....	6.75	.....	2.84	.....	9.06	.....	0.13	.....	11.88
16	.....	0.85	.....	5.50	6.10	.....	.....	6.57	0.22	.....	.....	12.73
29	.....	1.81	.....	6.88	.....	2.80	.....	8.89	.....	0.20	.....	11.70
30	2.11	.....	7.41	.....	5.04	.....	9.72	.....	.....	0.20	14.69	
40	.....	1.75	.....	6.94	.....	3.68	.....	8.97	0.28	.....	.....	12.52
64	2.00	.....	.....	6.69	.....	3.96	.....	9.01	0.32	.....	13.05	
45	2.33	.....	7.48	.....	.....	2.47	9.97	.....	.....	0.16	.....	12.36
43	.....	1.50	7.32	.....	.....	3.77	.....	9.00	.....	0.18	.....	12.64
34	2.19	.....	7.46	.....	6.89	.....	9.90	.....	0.25	.....	16.66	
33	2.24	.....	.....	6.25	.....	2.76	.....	8.84	0.35	.....	.....	11.45
4	.....	1.73	7.25	.....	.....	2.95	9.19	.....	.....	0.18	.....	11.96
39	2.33	.....	.....	5.78	4.21	.....	.....	8.32	0.21	.....	.....	12.57
48	.....	1.93	6.95	.....	5.59	.....	.....	9.06	.....	0.18	14.58	
31	2.27	.....	.....	6.75	5.96	.....	9.17	.....	.....	0.15	15.21	
68	2.17	.....	7.44	.....	4.36	.....	9.90	.....	0.29	.....	14.26	
5	.....	1.49	7.23	.....	.....	2.12	.....	8.90	.....	0.18	.....	11.11
2	.....	1.68	7.53	.....	.....	3.55	9.42	.....	0.21	.....	.....	12.84
12	.....	1.76	6.97	.....	.....	2.44	.....	8.93	.....	0.20	.....	11.40
25	2.16	.....	7.00	.....	5.84	.....	9.38	.....	0.22	.....	15.18	
42	.....	1.97	7.38	.....	4.16	.....	9.60	.....	0.25	.....	13.60	
33	2.24	.....	.....	6.25	.....	2.76	.....	8.84	0.35	.....	.....	11.45
46	.....	1.35	7.24	.....	.....	4.09	.....	8.89	0.30	.....	.....	13.15
50	2.06	.....	.....	6.39	4.75	.....	.....	8.67	0.22	.....	13.48	
26	2.08	.....	.....	.....	.....	3.28						
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	.....	12.34
A	XIII.	XII.	XIV.	X.	X.	XV.	IX.	XV.	XIII.	XII.	IX.	XVI.
B	2.18	1.64	7.26	6.41	5.40	3.16	9.58	8.80	0.27	0.17	14.52	12.18
C	1.92		6.91		4.05		9.09		0.22		13.02	

TABLE V.—MILK OF WOMEN FROM 25 TO 30 YEARS OF AGE. (Third Lustrum.)

A = No. of cases above or below the general average.
B = Averages for A.
C = Averages for women from 25 to 30 years of age.
D = General averages for all ages.

No. of sample.	Albuminoids.		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
	Above av.	Below av.	Above av.	Below av.	Ab. av.	Bel. av.	Above av.	Below av.	Above av.	Below av.	Above av.	Below av.
13	2.40	.....	.....	6.45	6.01	.....	.....	9.07	0.22	.....	15.07	
14	2.52	.....	.....	6.44	4.95	.....	9.23	.....	0.27	.....	14.16	
47	4.86	.....	.....	5.40	.....	3.36	9.46	.....	.....	0.20	13.35	
8	2.15	.....	.....	6.51	.....	2.31	.....	8.94	0.28	.....	.....	11.40
67	.....	1.96	7.28	.....	4.74	.....	9.54	.....	0.30	.....	14.28	
32	.....	1.53	.....	5.84	5.62	.....	.....	7.21	.....	0.14	.....	12.99
24	.....	1.94	7.45	.....	.....	3.61	9.56	.....	.....	0.16	.....	13.02
9	2.05	.....	7.08	.....	.....	3.00	9.26	.....	.....	0.13	.....	12.31
66	.....	1.11	7.07	.....	.....	2.73	.....	8.40	0.22	.....	.....	11.13
23	2.10	.....	.....	6.61	.....	4.02	.....	8.91	.....	0.20	.....	12.88
10	.....	1.45	7.19	.....	.....	2.11	.....	8.81	.....	0.19	.....	10.91
27	1.98	.....	7.00	.....	.....	2.44	9.19	.....	0.21	.....	.....	11.84
52	2.15	.....	.....	6.76	6.78	.....	.....	9.07	.....	0.16	15.89	
55	2.43	.....	.....	6.57	4.94	.....	9.27	.....	0.27	.....	14.20	
43	.....	1.50	7.32	.....	.....	3.77	.....	9.00	.....	0.18	.....	12.64
44	.....	1.49	7.31	.....	4.34	.....	.....	9.01	0.21	.....	.....	13.17
A	VIII.	VIII.	VIII.	VIII.	VII.	IX.	VII.	IX.	VIII.	VIII.	VI.	X.
B	2.58	1.62	7.21	6.32	5.34	3.04	9.36	8.71	0.25	0.17	14.49	12.23
C	2.10		6.77		4.04		9.00		0.21		13.08	
D	1.995		6.936		4.131		9.137		0.201		13.267	

Fat, like the albumenoids, is much in excess of the general average immediately after parturition, being 4·93 per cent. After the eleventh day it falls, being only 3·97 per cent.

The saline constituents are nearly constant during all stages of lactation, although slightly in excess during the first ten days.

The sum of solids not including fat does not vary greatly. Its amount in the first interval is 9·15 per cent, the general average being 9·14.

Interval since Nursing.—Nearly all the samples were drawn two hours after nursing, but certain ones, more especially Nos. 18, 32, 33, 39 were drawn immediately. In fat, albumenoids, salts, and total solids, they were in excess of the general average.

(To be continued).

ON NITROGEN IN ARTIFICIAL MANURES.

By J. OSTERSETZER.

The fertilising property of nitrogen in manures varies with the source it has been obtained from. Some years ago Peruvian guano occupied the foremost position as a source of nitrogen. Essentially an organic substance, more than one-half of the nitrogen contained in Peruvian guano appears in the state of ammonium sulphate, phosphate, and oxalate, whilst the remainder presents itself in the form of guanin, uric acid, &c. At the present moment the most important sources of nitrogen, both as to quality and quantity, are sodium nitrate of the Chili saltpetre, and ammonium sulphate, chiefly manufactured from gas-liquor. Next we find a great number of organic substances containing nitrogen in combination with the other elementary constituents of organic matter. The molecular relation of nitrogen to carbon, hydrogen, oxygen, and sometimes sulphur, differs in various organic substances, hence their different properties of assimilation when applied as fertilisers. Practical results have established a scale, so to speak, according to which nitrogen from various sources may be classified as to its specific value.

Viewing this subject from a theoretical stand-point, I have selected four organic substances to represent the great number of nitrogenous organic combinations, used as manures either as such, or as additions to artificial fertilisers, and endeavoured to ascertain the relative properties of nitrogen from different sources. I have taken as a basis, first, the degree of solubility of nitrogen in water, citric acid, sulphuric acid, and ammonium citrate, an intermediate reagent adopted in determining the so-called retrograde phosphates in manures, and secondly, the dissociation of nitrogen by subjecting the organic substances to the process of destructive distillation.

I. *Solubility.*

The substances selected for determining the degree of solubility were Peruvian guano, dried blood, bone meal, and wool waste. A weighed quantity of the substance of a known percentage of nitrogen I first treated with water at boiling-point, filtered, washed and dried the insoluble residue, separated the same from the filter, and made a determination of nitrogen with soda-lime in the usual way. The difference of this result and the nitrogen originally contained in the substance showed the amount of nitrogen soluble in water. New weighed portions of the organic substances were treated with a large excess of an ammoniacal solution of ammonium citrate in the cold for 12 hours, and with rectified sulphuric acid of the sp. gr. 1·85, and a concentrated solution of citric acid at boiling heat; then diluted and the insoluble residues collected on filters, carefully washed until the last traces of either alkaline or acid reaction of the filtrate disappeared, the residues treated in the same manner as before by ultimately making a determination

Table I.

Substance.	Containing Nitrogen in 100 parts.	N soluble in Water.	N soluble in Ammonium Citrate.	N soluble in Citric Acid.	N soluble in Sulphuric Acid.	N left insol. in Sulphuric Acid.	Per cent of the N soluble in Water.	Per cent of the N soluble in Ammo. Citrate.	Per cent of the N soluble in Citric Acid.	Per cent of the N soluble in Sulphuric Acid.	Per cent of the N left insoluble in Sulphric. Acid.
Peruvian guano	5·88	3·78	1·10	0·27	0·58	0·15	64·27	18·71	4·59	9·88	2·55
Dried blood (at 100° C.).	15·91	2·35	2·32	3·98	6·46	0·80	14·77	14·59	25·00	40·55	5·09
Bone meal	3·50	0·10	0·05	0·30	2·65	0·40	2·86	1·43	8·57	75·71	11·43
Wool waste	9·12	0·00	0·00	5·60	2·23	1·29	—	—	61·41	24·44	14·15

Table II.

Substance.	Containing N in 100 pts.	Nitrogen formed in the shape of H_3N.	N yielded as N, &c.	N left in the Char.	Per cent of the N formed as H_3N.	Per cent of the N yielded as N, &c.	Per cent of the N left in the Char.
Peruvian guano	5·88	4·90	0·84	0·14	83·33	14·27	2·40
Dried blood (dried at 100° C.) . ..	15·91	7·57	6·24	2·10	47·58	39·23	13·19
Bone meal	3·50	1·68	1·47	0·35	48·00	42·00	10·00
Wool waste	9·12	4·90	2·82	1·40	53·73	30·92	15·35

of nitrogen in the insoluble residues. The difference of nitrogen soluble in water and that soluble in ammonium citrate showed the amount of soluble nitrogen due to ammonium citrate. Again the nitrogen soluble in ammonium citrate deducted from the total nitrogen soluble in citric acid indicated the percentage of nitrogen due to the action of the latter reagent, whilst the addition of the three results subtracted from the total nitrogen made soluble by sulphuric acid showed the amount of nitrogen rendered soluble by sulphuric acid only. I have obtained the results given in Table I:—

The same substances were next subjected to—

II. *Destructive Distillation.*

A weighed quantity of the organic substance was heated in a combustion-tube, a portion of the nitrogen evolved in the shape of H_3N, which was estimated in the usual way by titration. The char left in the tube, carefully collected, and the amount of nitrogen determined, the difference or loss of nitrogen was due to the nitrogen leaving the organic substance as nitrogen gas or nitrogen oxides. I give the results in Table II.

With the exception of dried blood, an analogy appears to be existing between the nitrogen left untouched by sulphuric acid and the nitrogen left in the char.

These results also plainly show that sulphuric acid is capable of rendering a very large percentage of the nitrogen in organic substances in a soluble state, thus presenting the nitrogen to the plants in a most perfect form of division.

Goulding's Manure Works,
North Wall, Dublin.
December 2, 1884.

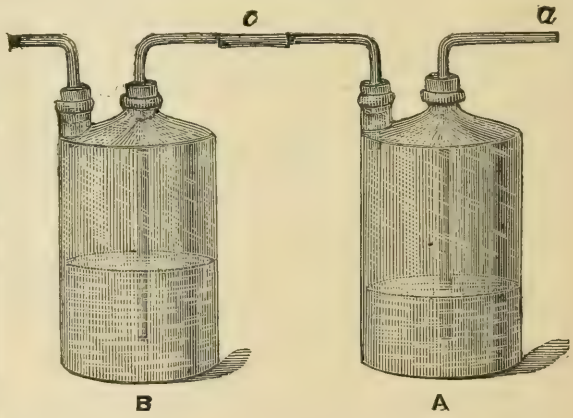
A NEW DEVICE FOR OBTAINING HYDROGEN SULPHIDE.

By HARRY N. DRAPER, F.C.S.

Were it not that the occurrence in the laboratory o cases in which a quite small quantity of hydrogen sulphide is required is so frequent, I should with reluctance propose to add to the already long list of apparatus for its production.

Water satutated with the gas is often very useful, but the solution does not keep well, and in the smallest and best arranged contrivances in which iron sulphide is employed the escape of gas continued after the acid has been withdrawn from its contact. The plan which I venture to suggest avoids all escape of gas except when the apparatus is in actual use, and then if the hydrogen sulphide is doing useful work there is no escape into the surrounding air.

The simplest form of construction is that shown in the engraving, where A is a two-necked bottle containing ammonium sulphide and B another such bottle filled to a somewhat greater height with sulphuric acid diluted with four volumes of water. Through the tube *a* a gentle current of air is forced either by water pressure or by a small hand blower.*



No free ammonia passes through B (as may be easily demonstrated by adding a few drops of phenol-phthalein solution to the water of the wash-bottle), and remarkably enough there is no deposition of sulphur in the acid liquid, which remains perfectly clear.

The arrangement has its weak point. The gas produced is not of course pure, but is largely mixed with air. I venture to think nevertheless that, as it has supplied a want to myself, it may do so to others.

The interception of a glass or vulcanite stopcock at c will prevent any possibility of the diffusion of ammonium sulphide into B when the apparatus is at rest.

I have not yet tried the experiment of forcing the vapour from fuming hydrochloric acid into a solution of sodium sulphide, but it seems very probable that this modification of the original idea would give a good result.

Dublin, December 4, 1884.

* Where the local coal gas pressure is sufficient (which is not the case in Dublin) this would afford quite the most convenient means of producing a continuous current.

THE DETERMINATION OF MOISTURE IN FODDER.

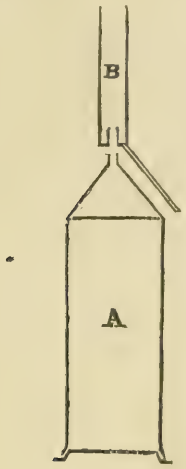
By F. E. FURRY.

Those who have had occasion to analyse crude fodders, as grass, clover, corn-stalks, ensilage, and the like, know how much depends on an accurate determination of the total moisture, and at the same time how many difficulties present themselves in an attempt to handle a fair average sample, which must necessarily be quite large.

After considerable unsatisfactory experience with porcelain and platinum evaporating dishes, which were not only cumbersome to weigh but invariably left the sample unequally dried unless exposed to heat for a long time, a very simple apparatus was tried which has since been used exclusively.

The annexed figure will be understood without much explanation.

A is a cylinder of light tin 18 c.m. in length by 7 c.m. in diameter, provided at both ends with wire gauze disks, one of which is removable. The end of the cylinder provided with the stationary disk is tapered to a tube having a diameter of 1 c.m. B is the "chimney." During the process of drying, A is to be placed in the drying oven



heated to the desired temperature, and B, fitting on it as shown in the cut, is to project into cooler air, above. A strong draft is thus established. Any moisture contained between the gauze disks of A will be carried upward into B, where some will escape into the air, and some will be condensed on the walls and escape by the small exit tube at the side into a dish of sulphuric acid provided for the purpose. This latter tube has a diameter of 0·5 c.m.

In practice the part A is thoroughly cleaned, dried, and weighed. The substance to be treated is then put in it, the bottom disk replaced, and the whole weighed again. A comparatively short time is required for complete desiccation. When a cold substance held over the chimney does not deposit moisture, the chimney is removed, and the part A cooled and again weighed. With a little experience not more than one more weight is necessary. If any volatile substance, as ammonia, is likely to be given off, which it is desired to estimate, the chimney is replaced by an Erlenmeyer flask containing a standard solution for its retention and measurement. This arrangement is also employed when natural manures and the like are under examination in order to prevent the escape of unpleasant and injurious odours into the working room. In either case the flask is necessarily connected with suction.

The removable disk may be "wired" if necessary to prevent bending. Any good tin-smith will construct the whole affair in a few minutes for seventy-five cents.

Cornell Univ. Chem. Laboratory,
Ithaca, N.Y., Nov. 21, 1884.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

December 13th, 1884.

Prof. Guthrie, President, in the Chair.

The following communications were read :—

"*On the Effect of an Electrical Current on the Rate of Thinning of a Liquid Film*," by Profs. A. W. Reinold, F.R.S., and A. W. Rücker, F.R.S., read by Prof. Reinold. In 1877 the authors communicated to the Royal Society an account of some experiments upon the electrical resistance of liquid films. The results then obtained showed that there was some disturbing influence present, and the authors now find this to be the action of the current upon the film itself. The films experimented upon were, as in the original experiments, cylindrical and vertical, formed upon two co-axial platinum rings, which are the electrodes by which an electric current can enter and leave the film. The mode of formation of these films, and the precautions necessary to keep them from gaining or losing moisture by condensation or evaporation, have been already described before the Royal Society (*Phil. Trans.*, 1881, Pt. II.). When such a film just formed is left to itself it shows a set of colours of different orders arranged in horizontal bands. As it thins under the action of gravity these bands gradually broaden out and descend. A black band soon appears at the top, which likewise extends downwards. If a current is now passed downwards through the film the motion of the colour bands is accelerated, showing that the effect of the current is to assist gravity in thinning the film; the black band, however, becomes in part or entirely white. This upon examination is found to be due to the following action :—The film is not directly dependent upon the upper ring, but is attached to it by a comparatively thick mass of liquid. The action of the current is to transfer liquid in its own direction, thus, like gravity, thinning the film. The mass of liquid, however, on which the film hangs by this same action is forced down into the black portion, which consequently becomes white. If the current be passed upwards the reverse effects occur; the downward motion of the bands is retarded, or, with a strong current, reversed. The explanation is precisely the same as before; the liquid is transferred along the film in the direction of the positive current. It sometimes collects in the form of pendent drops attached to the upper ring; these increase in size, and stream down the sides of the film. Prof. Reinold then formed a plane film between two horizontal wires. The film was illuminated by the lime-light, and its image projected upon a screen. The motion of the bands of colour in the direction of the current produced by 50 Grove's cells was clearly shown.

In a discussion which followed upon the transference of matter with the current,

Prof. Ayrton described some experiments recently made by Prof. Perry and himself, which showed that certain metals were carried through mercury in the direction of the current.

Mr. Boys remarked upon the apparent inertia of the film. The current seemed to require time to develop its action, no motion of the colour-rings being visible for some seconds after making the current.

Dr. Stone exhibited a Tuning-fork Interruptor Commutator. This is an instrument for reversing an electric

current through a circuit a given number of times per second. From the free end of a spring, kept vibrating in unison with an electrically-maintained fork by an electromagnet in the circuit of the fork acting upon an iron armature attached to the spring, project two small aluminium plates, side by side, but insulated by ebonite from the spring and from each other. These are connected by fine wires, which do not interfere with the vibration of the spring, to screws upon the base of the instrument to which the poles of a battery are joined. The motion of each plate is arrested upwards and downwards by aluminium stops, so that there are four such stops arranged at the corners of a rectangle. They are connected in pairs, diagonally, and each pair is in communication with one end of the external circuit. Thus, when the spring is up the current flows to the aluminium plates, and is transmitted through the circuit in one direction; when the spring is down it flows by the lower stops in the opposite direction. The electromotive force is thus reversed in the circuit twice as many times as the fork vibrates per second.

Mr. Lewis Wright exhibited his New Oxy-hydrogen Lantern Microscope. Details of this instrument will shortly be published. Geological, medical, and biological specimens were exhibited upon the screen with great distinctness, the definition being singularly perfect under the highest powers.

NOTICES OF BOOKS.

Diaries for 1885. London: Letts, Son, and Co., Lim.

The enormous demand that now exists for diaries and other time-saving publications is fully shown by the multitude and variety of these books that are produced annually by the firm of Messrs. Letts and Co. For the incoming year the useful publications manufactured by this firm maintain their high standard combined with remarkable cheapness, ranging as they do in price from a few pence to a couple of guineas.

Some of the largest sized diaries, with one day to the page, although their intended place of usefulness is the counting-house, would form excellent note-books for the laboratory table, as each day's experimental work could be therein inserted.

The professional diaries are sure to find an extensive field on account of the useful and appropriate information they contain; the Medical Diary, for instance, is ruled for obstetric engagements, vaccination, nurses' addresses, thermometric fluctuations, &c. The same, in fact, applies to most of Messrs. Letts's Diaries, there being a large number of them, varying in size and price, for the Army and Navy, the Clergy, Farmers, Travellers, &c., each containing information of the kind most likely to be required by the different professions.

The Housekeeper's Account Book and the Household Expenses Book are good in design and workmanship as well as moderate in price. To the same domestic class of diaries belong the Game Book for Sportsmen, the Stable Expenses Book, the Farm Expenses Book, and the Improved Rent-Book. A good supply of the latter might be sent over to Ireland.

Townson and Mercer's Catalogue of Chemical and Physical Apparatus and Chemicals.

This enterprising firm have now issued a third and greatly enlarged illustrated catalogue. On examination it will be found exceedingly complete, including a number of recently-introduced instruments, such as Scheibler's calcimeter, Stead's and Elliott's apparatus for the analysis of furnace and chimney gases, Rammelsberg's and Geissler's burettes, Bunte's gas burettes for furnace gases, Schwarz's and Staedel's nitrogen apparatus, a good assortment of filter-pumps and presses, Le Bel Henninger's and Glyusky's tubes for fractional distillation, Victor Meyer's vapour-density apparatus, &c.

We may also notice sets of apparatus for certain especial purposes, such as the beer-set, the wine-set, apparatus for determining sulphur in spent oxide, the apparatus used by the Metropolitan gas referees for testing the purity of coal-gas, MacIvor's and Sacker's apparatus for testing lubricating oils, and Schützenberger's apparatus for determining dissolved oxygen in water.

The physical department includes apparatus for pneumatic, hydrostatic, thermic (under which head barometers are, rather curiously, included), optical, acoustical, and electrical experiments.

It appears that Messrs. Townson and Mercer are the sole British agents for Becker's chemical balances, and that they supply Schleicher and Schüll's chemically pure filter-paper, and Fletcher's chemical gas-appliances.

Arithmetical Physics. Acoustics, Light, and Heat (Part I. A.) *Magnetism and Electricity* (Part II. A.). By C. J. Woodward, B.Sc. London: Simpkin, Marshall, and Co, Birmingham: Cornish Bros.

The first part of this little work contains a very novel and interesting feature; the author formally and boldly comes forward as an apologist for the examinational system of education, which he thinks ought not to be regarded as "cram." Now, for examinationism thus to stand on the defensive is already a great point gained. "*Qui s'excuse s'accuse.*" But let us examine Mr. Woodward's argument. He writes:—"I do not admit for a moment that this work is a 'cram-book.' My aim has been to make it strictly educational, by fixing clearly in the minds of students the first principles of Physics. Students who have a clear perception of these first principles will undoubtedly pass best at an examination, but because they pass are we to say that of necessity they are crammed? To have an examination in view does not detract from the attainment of knowledge or impair the reasoning power of a student. The very object of an examination is to sift from those who understood the principles of the subject others who have but a superficial knowledge." Mr. Woodward then proceeds to quote one J. G. Fitch, who in certain "Lectures on Teaching" said:—"Every examiner who knows his business can easily discern the difference between the knowledge which is genuine and has been well digested, and that which is superficial and is specially got up to deceive him. Dishonestly prepared men undoubtedly come up for examination, but they do not pass (?), and the blame of the transaction rests with those who send them up, not with the examinations themselves."

Perhaps Mr. Woodward and Mr. Fitch have never met with the famous and truthful dictum of Professor Huxley that "in these days we study not to know, but to pass, and the consequence is that we pass, and don't know." Here is an admission on the part of one who has had most extensive opportunities of observing that "passing" is not a function of knowledge. This our own experience corroborates. We meet with men who have passed this or that examination with honour, but yet have merely a talking acquaintance with Science. We may further ask the author, if "dishonestly prepared men do not pass," how it comes that "coaches," "grinders," &c., who make it their business to study the idiosyncrasies of examiners, and can even predict many of the very questions which will be put, continue to exist and do really get their men passed? If "to have an examination in view does not detract from the attainment of knowledge or impair the reasoning power of a student," what can be the origin of the saying, not uncommon among University tutors, that "Mr. So-and-so might do well if he did not think?"

But it will be fairer to go to the fundamental principles of the matter. A man, in studying any physical or

natural science, must, as it seems to us, have one of three legitimate ends in view. He must aim at the cultivation of certain of his own faculties, or he must wish to prepare himself for extending the present sum of human knowledge, or for applying such knowledge to practical ends. Whichever of these three be his object, he must above all things master the art of acute and accurate observation, and of tracing phenomena to their causes. Without he acquires these powers his word knowledge of "principles" will profit him nothing. But where is the examiner bold enough to assert that he can gauge the suggestiveness, the extent of mental resources, of a student, or his power of detecting and appreciating unrecorded, mis-recorded, and anomalous phenomena? Hence these powers, though far higher than the mere receptivity which enables a youth to absorb and reproduce the knowledge of others, count for nothing in an examination. As a natural consequence of the present system, teachers who have to pass their pupils rarely, if ever, attempt to train them to become original observers. It may even be said that the examinational system is a main cause why England is so much less fruitful in scientific research than is, *e.g.*, Germany.

Concerning the decided examinational character of these works, we need merely say that in Part I. A., whilst the lessons and exercises occupy 37 pages, 46 are devoted to the questions given by the Science and Art Department from 1874 to 1884; those set in the "Matriculation Examinations" of the University of London from 1864 to 1881 with the answers. In Part II. A the lessons and exercises fill up 27 pages, whilst the questions given at the Science and Art Department Examinations 1874 to 1884, and at the Oxford and Cambridge Local Examinations 1874 to 1883, with their answers, cover 25. Leaving one side, however, the dominant examinational character of these works, they will be useful manuals for students who have already studied experimentally the phenomena here discussed.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 22, December 1, 1884.

Observations on the Claim of Priority made by M. Leplay, relating to the Formation of Potassium Nitrate in Vegetation.—MM. Berthelot and André.—The authors are acquainted with the researches of M. Leplay on the formation of sugar, but are surprised that he claims a priority as regards the nitrates. After having re-read his eight memoirs they find that there is nothing in common between his researches and theirs, either as regards the facts or the conclusions.

The Fluoric Apatites.—A. Ditte.—The author has prepared and studied the fluor-arseniates and fluoro-vanadiates.

Action of the Induction-Spark upon Phosphorus Trifluoride.—H. Moissan.—If the apparatus and the material are perfectly dry phosphorus is deposited on the interior of the tube, and there is a formation of gaseous phosphorus pentafluoride. If a trace of moisture is present phosphorus is still deposited on the glass, but the gas contains a gradually increasing proportion of silicon fluoride, and the internal surface of the tube is completely roughened. The transformation of phosphorus fluoride into silicon fluoride by the passage of the spark is never complete, as an equilibrium seems to be reached. The gaseous mixture resulting from the decomposition of phosphorus fluoride not perfectly dry, if brought in contact with a solution of potassium iodide, displaces the iodine, and gives an intense violet colouration with starch-paste. But if we make the same experiment with phosphorus fluoride, perfectly dry and partially decomposed by the induction-spark, there is no colouration.

Hydro-ferrocyanic Acid and its Derivatives.—A. Etard and G. Bémont.—The authors propose to represent ferro-cyanogen by a hexagonal formula.

The Action of Phosphorus Perchloride upon the Aromatic Ethers.—A. Colson.—On heating paraxylenic mono-ethylene with two and a-half times its weight of phosphorus perchloride there are given off hydrochloric acid, phosphorus protochloride and oxychloride, and ethyl chloride, whilst from the residual liquid is obtained terephthalic aldehyd in fine colourless crystals.

The Determination of Odoriferous Essential Oils.—A. Levallois.—If an aqueous or alcoholic solution of bromine is poured into water or alcohol holding in solution traces of essential oil, there comes a moment when, in spite of stirring, the liquid takes a yellow colouration, due to an exdess of bromine, which is the more easily detected as the liquid previously is quite colourless. At the same time the specific odour of the oil in question has disappeared, though it is still distinctly perceptible when a few drops of the bromine reagent have still to be added. A third indication of the end of the reaction (at least in case of an aqueous solution) is the sudden appearance of an insoluble, whitish, resinous body, which lines the sides of the vessel after stirring. The quantities of bromine required are proportional to the quantity of essential oil present in solution. But it is necessary to make a correction of two-tenths or three-tenths c.c. for the quantity of bromine required to produce a perceptible colouration in the volume of liquid employed, when it is 20 or 30 c.c. It is necessary to concentrate the essences in a small bulk.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xiii., Part 5.

Underground Water and the Moisture of the Soil.—Fr. Hofmann.—The author contends that, in order to understand the distribution of moisture in the soil, we must distinguish three strata which differ in their power of receiving and giving up water. The upper layer, or "evaporation zone," depends on the weather, and is exposed to the greatest fluctuations in its proportion of moisture. After persistent drought it may take up the entire rain of six or even twelve months, so that not a drop passes into the lower strata. This zone is the more important in a sanitary point of view as it is exposed to contamination from above, to the direct invasion of pathogenous fungi, and to both the highest and the lowest temperatures. The middle stratum, which the author terms the "transit-zone," has a tolerably constant proportion of water, depending on the size of the soil capillaries. Evaporation has no influence upon this region, and an influx from above modifies its proportion of moisture only in as far as the water which penetrates in traverses the capillaries more or less rapidly according to their size. According to the thickness of this stratum its quantity of water may be very considerable, equal to the downfall of several years. The lowest stratum is called the zone of the capillary ground-water level. It begins at the surface of the subterranean waters, and its moisture depends on the nature of the capillary intervals. The author concludes that all impurities, organic or inorganic, placed upon the surface remain in the upper zone and cannot be washed down into the subsoil waters, even by heavy rains.

Formation of Saline Deposits, with particular reference to that of Stassfurt.—Dr. E. Pfeiffer.—A geological study.

Researches on the Influence of Different Depths of Sowing upon the Germination of Cultivated Plants.—Prof. E. Wollny.—The author concludes that the deeper seeds and tubers are planted, the later and the more irregular will be the appearance of the young plants upon the surface of the soil. At a certain depth the number of plants which come up is greatest; if the seed is set either deeper or shallower, the number of plants decreases. Shallow sowing, within certain limits, is most advantageous, both as to the number of plants obtained and their equal and rapid development. The most suitable depth depends on the kind of plant, on the nature of the soil, and on the weather. The smaller the seeds or tubers, the less favourable the weather, and the more compact the soil, the more essential is shallow sowing.

Manuring Beets with Chili Saltpetre.—Fr. Müller.—Chili saltpetre is said to give better results than the same value of ammoniacal salt.

The Manufacture of Bone-Dust.—Prof. J. König.—The author shows that when bones, previous to grinding, are freed from fat by treatment with benzol, they are purified from ingredients which have no agricultural value.

Manurial Experiment with Barley.—H. Wäterling.—An exclusive use of phosphoric acid gave a worse result than the absence of manure; the same was the case with nitrate of soda alone. The two in conjunction gave an increase both in the gross and the nett yield.

Journal für Praktische Chemie.
New Series, Vol. xxx., Part 3.

Action of Chlorocyan upon Ortho- and Para-amidophenol.—Dr. J. Berlinerblau.—An extensive paper which does not admit of useful abridgment.

Action of Chloro-carbonic Ether upon Nitrogenous Organic Compounds.—E. von Meyer.—The author has examined the behaviour of chloro-carbonic acid with cyanethine, the composition of carboxethyl-cyanethine; the behaviour of the latter body with ammonia and with aniline; the composition of carbanilido-cyanethine: the "oxy-base" obtained from cyanethine and chloro-carbonic ether; and the action of chloro-carbonic ether upon certain amides.

Simple and Productive Method of obtaining Anthranilic Acid.—H. Kolbe.—In a preliminary communication on isatine the author has briefly described isatic acid as an oxidation product of isatine. If this acid is heated with strong hydrochloric acid on the water-bath it is resolved into carbonic acid and anthranilic acid, which latter, on evaporating to dryness, remains in chemical combination with the hydrochloric acid as a white crystalline mass. Its aqueous solution precipitated with ammonia and mixed with acetic acid gives a copious precipitate of anthranilic acid. It may be obtained chemically pure by treatment with animal charcoal and recrystallisation.

Decomposition of Benzo-nitrile by Fuming Sulphuric Acid.—A. Pinner.—A reply to a paper by F. Gumpert in a former part of this journal.

Oxychlorides and Analogous Metallic Compounds.—G. André.—The author describes the oxychlorides of calcium, barium, strontium, magnesium; the oxychlorides of zinc; the chlor-zinc-ammonium compounds and the corresponding bromides; the double salts of lead chloride and bromide; and the lead and mercury oxychlorides and oxybromides.

On Perseite.—A Muntz and V. Marcano.—Perseite is a form of sugar occurring in the fruits of *Laurus persea*. Perseite is an isomer of mannite, but is distinguished by its melting-point and by its lower rotatory power after the addition of borax. Dulcite, which has the same composition and the same melting-point as perseite, in a boracic solution has no action upon polarised light.

Phosphorus Terfluoride.—H. Moissan.—*Comptes Rendus.*

Permeability of Silver for Oxygen.—L. Troost.—From the *Comptes Rendus*, as are also the three succeeding papers:—

Compounds of Gold Chloride with Phosphorus Chlorides.—L. Lindet.

Constitution of Certain Simple Cyanogen Compounds.—G. Calmels.

Phthalic Alcohol and Accessory Compounds.—A. Colson.

Justus Liebig's Annalen der Chemie,
Vol. 225, Part 3.

Communications from the Chemical Laboratory of the University of Jena.—These consist of "Researches on the Affinities of Carbon," by A. Geuther, and a memoir on "Certain Derivatives of Aldehyd and Æthyliden and on the Magnitude of the Carbon-Monoxide Affinities of Carbon," by Dr. R. Rübencamp. The results of these two papers may be summarised as follows:—No mixed acetates exist, but in their stead there always occur the two simple ones. The mixed oxygen ethers of ethyliden alcohol can be obtained. For the latter it is indifferent into what series the oxygen-residues enter, as identical compounds are always formed. Hence it follows that the two "carbon monoxide affinities" are not different from each other, but respectively equal.

Oleum Cynæ,—a Contribution to the Knowledge of the Terpenes.—O. Wallach and W. Brass.—The authors have obtained from the crude oil a compound $C_{10}H_{18}O$, isomeric with borneol, and of the boiling-point 176° to 177°, sp. gr. 0·92297 at 16°, and the vapour density 5·1168. Cyneol is optically inactive. Its behaviour has been examined with the hydracids of the halogens, with the halogens themselves. From cyneol the authors have obtained cynene, a hydrocarbon $C_{10}H_{16}$.

Constituents of Certain Ethereal Oils.—O. Wallach.—The author shows that the chief constituent of cajeput oil (cajeputene) is identical with the cynene mentioned in the last paper, and that it is closely related to, though not identical with, the hesperidene present in the essential oils of the Aurantiaceæ.

Communications from the Chemical Institute of the University of Halle.—These consist of a paper by Bernhard Priebs on the Action of Benzaldehyd on Nitromethan and Nitro-ethane, and a memoir by G. Baumert on the Lupinidine of *Lupinus luteus.*

On Dinitrotoluol.—W. Staedel.—The author confirms by further experiments his opinion on the constitution of dinitrotoluol as given in *Annalen*, 217, p. 205.

Bulletin de la Société Chimique de Paris.
Vol. xlii., No. 11, December 5, 1884.

This number opens with the discourse pronounced by Prof. Schützenberger at the funeral of A. Hanninger, Nov. 10th ult.

The Laboratory and the Teachings of J. B. Dumas.—F. Le Blanc.—An extract from *Le Génie Civil.*

Casting Porcelain.—Ch. Lauth.—A long account of the process known as "casting" porcelain, illustrated with two figures.

Degeneration of Brewer's Yeast.—H. Bungener.—The author describes a degeneration of yeast not due to the presence of foreign *Saccharomyces*, of *Mycoderma aceti*, or of the bacterium of lactic fermentation, and brought about by the abnormal composition of the worts in which it vegetates.

Preparation of Crystalline Anhydrous Zinc Acetate.—J. Peter and O. de Rochefontaine.—The authors take the

product of the desiccation at 150° of the ordinary crystalline zinc acetate and add to it 8 to 10 times its weight of an acetic acid very free from water. The mixture is kept for an hour at a gentle boil in a flask fitted with a reflux tube. A portion is dissolved, and it is poured whilst boiling upon a filter, avoiding access of air as much as possible. The liquid is received in a bottle which is stoppered and allowed to cool slowly. The sides of the bottle become lined with a crystalline deposit, which when drained and dried between blotting-paper possesses the composition of anhydrous zinc acetate. The crystals do not lose weight in the stove or in a vacuum, and do not absorb water on exposure to the air.

Phenic Acids of Commerce.—Charles Casthelaz.—The author endeavours to give a definition of the terms "crude carbolic," 60 per cent, and liquid carbolic at 100, at 95, and 50 per cent.

Cosmos les Mondes.
No. 13, December 5, 1884.

This issue contains no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c.,
September and October, 1884.

This issue contains no chemical matter, except extracts from the *Comptes Rendus.*

MISCELLANEOUS

New Work on the Wool Fibre.—We learn with pleasure that Messrs. Palmer and Howe, of Manchester, are about shortly to publish a monograph on the structure of the wool-fibre, from the pen of Dr. F. H. Bowman, F.L.S., &c. Our readers will, doubtless, remember the treatise on cotton-fibre, by the same author, which we had the pleasure of noticing some time ago, and which has since continued to win golden opinions both from theoretical savants and from practical men. The forthcoming work, which will be copiously illustrated, discusses the wool-fibre both from a mechanical and a chemical point of view, and will, we believe, throw an important light upon the fundamental principles of the tinctorial arts.

British Association.—At the close of the British Association Meeting at Montreal, the suggestion was brought forward that, in commemoration of the meeting, and as a recognition of the hospitality with which the members of the Association had been treated in Canada, it would be a graceful act to form a fund for the purpose of founding a gold medal at the McGill University at Montreal. After consultation with the authorities at the University it was agreed that, subject to further consideration, the medal should be given annually, in the Faculty of Applied Science, in which there is at present no prize of this sort. Lord Rayleigh, the President of the Association, undertook to act as treasurer, and Mr. W. Topley and Mr. H. Trueman Wood as honorary secretaries. In answer to an appeal circulated amongst the members in Canada, and to a circular which has been issued in this country since the return of the Association, a sum amounting at present to £540 has been subscribed. Deducting the necessary expenses of printing and postage, there will remain an amount of something over £500 to provide the medal. The General Committee of the Association have agreed to provide from the funds of the Association sufficient for the purchase of a die, so that the interest resulting annually from the investment of the whole of the above amount may be available for the medal itself. The honorary secretaries will be glad to receive contributions from any members of the Association who may not yet have subscribed. These may be sent to them at the Society of Arts' House, John Street, Adelphi; or may be paid into the account of the fund, at Messrs. Hoare, 37, Fleet Street.

MEETINGS FOR THE WEEK

MONDAY, Dec. 22nd.—Medical, 8.30.
London Institution, 5.

TUESDAY, 23rd.—Institution of Civil Engineers, 8. (Anniversary).

FRIDAY, 26th.—Quekett Microscopical Club, 8.

SATURDAY, 27th.—Royal Institution, 3. "The Sources of Electricity," by Professor Tyndall.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to Charles Rumble and Frederick Sear, Chemists, both of Belmont Works, Battersea, in the County of Surrey, for an invention of "A New or Improved Process for the Separation of Glycerine from Fatty Substances,'' Dated 5th September, 1883, No. 4264.

NOTICE IS HEREBY GIVEN THAT the said Charles Rumble and Frederick Sear have applied under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, for leave to amend the Specification filed by them in pursuance of the said Letters Patent.

A copy of the Specification as proposed to be amended is open to public inspection at the Patent Office, and full details of the proposed amendment were advertised in the Official Journal of the Patent Office issued on the 5th day of December, 1884, No. 97, page 1264.

Any persons intending to oppose such application must leave particulars in writing of their objections to the proposed amendment at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C., within one month from the date hereof.

Dated this 5th day of December, 1884,

H. READER LACK,
Comptroller General.
CARPMAEL and Co.,
24, Southampton Buildings,
London, W.C.,
Agents for the Applicants.

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CHRISTMAS LECTURES.

LECTURE HOUR THREE O'CLOCK P.M.

PROFESSOR TYNDALL, D.C.L., F.R.S., M.R.I.—Six Lectures (adapted to a Juvenile Auditory) on THE SOURCES OF ELECTRICITY: Friction-electricity, Volta-electricity, Pyro-electricity, Thermo-electricity, Magneto-electricity; on Dec. 27 (Saturday), Dec. 30, 1884; Jan. 1, 3, 6, 8, 1865. *One Guinea the Course; Children under 16, Half-a-Guinea.*

AFTERNOON LECTURES BEFORE EASTER, 1885.

LECTURE HOUR THREE O'CLOCK P.M.

PROFESSOR HENRY N. MOSELEY, M.A., F.R.S.—Five Lectures on "Colonial Animals: their Structure and Life Histories;" on Tuesdays, Jan. 13, 20, 27, Feb. 3, 10. *One Guinea.*

PROFESSOR SIDNEY COLVIN, M.A.—Two Lectures on "Museums and National Education;" on Tuesdays, Feb. 17, 24. *Half-a-Guinea.*

PROFESSOR ARTHUR GAMGEE, M.D., F.R.S.—Four Lectures on "Digestion" (the subject to be continued after Easter); on Tuesdays, March 3, 10, 17, 24. *One Guinea (including Course after Easter).*

PROFESSOR DEWAR, M.A., F.R.S., M.R.I.—Eleven Lectures on "The New Chemistry;" on Thursdays, Jan. 15, 22, 29, Feb. 5, 12, 19, 26, March 5, 12, 19, 26. *One Guinea.*

CHARLES WALDSTEIN, Ph.D. Heidelberg, Hon. M.A. Cantab.—Three Lectures on "Greek Sculpture from Pheidias to the Roman Era;" on Saturdays, Jan. 17, 24, 31. *Half-a-Guinea.*

GEORGE JOHNSTONE STONEY, Esq., M.A., F.R.S.—Three Lectures on "The Scale on which Nature Works, and the Character of some of Her Operations;" on Saturdays, Feb. 7, 14, 21. *Half-a-Guinea.*

CARL ARMBRUSTER, Esq.—Five Lectures on "The Life, Theory, and Work of Richard Wagner (with Illustrations, Vocal and Instrumental); on Saturdays, Feb. 28, March 7, 14, 21, 28. *One Guinea.*

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Town Clerk.

Town Hall, Manchester,
3rd December, 1884.

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THE CHEMICAL NEWS.

VOL. L. No. 1309.

ON THE

TESTING OF ANILINE HYDROCHLORIDE ("ANILINE SALTS.")

By ROWLAND WILLIAMS, F.C.S., &c.

THE following hints may possibly be of use to chemists who have not had much experience in the testing of aniline hydrochlorate, or, as it is usually termed in calico-printing and other works, "aniline salts." The main points for investigation are—(1), absence or presence of grit; (2), degree of acidity; and (3), purity of the aniline from which the "salts" have been prepared.

(1) *Grit.*—This is tested for by dissolving a few ounces of the "salts" (if that quantity be available) in water, and allowing the insoluble matter (if any) to settle to the bottom of the vessel. A slight trace of grit will usually be found, but this may be disregarded. If, however, a considerable amount of gritty insoluble matter be present, it must be washed with water several times by decantation, then transferred to a tared crucible, ignited, and weighed as fairly pure silica. It is very important that the "salts" should be almost absolutely free trom grittiness, otherwise the "doctors" are attacked and the pieces "streaked" during the printing of aniline blacks.

(2) *Acidity.*—This estimation is made by dissolving a small quantity (say 2 grms.) of the "salts" in water, and titrating directly with standard NaHO, using either litmus or phenol-phthalein as indicator. In well-prepared "salts," the above-mentioned amount will require about 14 c.c. of normal NaHO for neutralisation of the free acid. It must be distinctly understood that, while a moderate degree of acidity is necessary for the production of a good black, an excesssive amount is extremely dangerous, on account of its liability to cause injury to the cloth during the process of steaming. Consequently, in the examination of "aniline salts" this important point must always be specially attended to, as "salts" are often faulty in this respect, although satisfactory enough in others.

(3) *Purity.*—In order to ascertain the purity (or otherwise) of the aniline from which the "salts" have been manufactured, it is necessary to obtain a little of the oil in the free state. This is accomplished by decomposing an aqueous solution of the "salts" with caustic soda, treating with ether, which readily dissolves the aniline, and afterwards evaporating off the ether. A few c.c. of the resultant aniline are then heated for some time at a temperature of 180° C., with an equal quantity of strong arsenic acid solution, and the resulting mass boiled with water. If the aniline be contaminated with toluidine, the aqueous solution is coloured crimson to a greater or lesser extent, according to the amount of impurity present, owing to the formation of rosaniline. If the aniline be pure, this colouration is, of course, not produced. It is also advisable to examine the "salts" for ammonium chloride (which I have occasionally detected in rather large amount), by heating with caustic soda in the usual way. Sulphates are also frequently present, but usually only as traces, and as they are probably due simply to a slight impurity in the hydrochloric acid employed in the manufacture of the "salts," their pressure may be disregarded. A small quantity of the "salts" when ignited in a crucible should not leave more than a slight trace of residue.

In addition to the foregoing purely chemical tests, it is usual, in a print-work, to submit each fresh delivery of "salts" to a practical test by making up a small quantity of colour in comparison with the "salts" in use, "striking off" side by side on a fent, steaming, &c., and comparing the purity and depth of shade of the aniline blacks produced.

ON JAPANESE TEA AND TOBACCO.

By J. TAKAYAMA.

THE tea-leaves are gathered in May, and quickly dried by exposure to air, and carefully sifted so as to separate dust and fragments of leaves. They are then subjected to steaming. This is done by introducing the leaves into a wooden tub, the bottom of which is formed of bamboo meshes, the tub being placed on an iron pan filled with water and heated from below. After thirty minutes, when the steam rises up, the wooden cover is taken off, and the contents are thoroughly mixed so as to steam uniformly all the leaves. This done, the tub is covered again with the lid. This process is repeated, and finally the contents are taken out and cooled. There is a tendency in leaves to adhere to the bamboo rod during mixing.

The leaves are now sufficiently softened to be rolled up between the hands by a gentle rubbing, after which the leaves are subjected to drying. This operation is a most difficult one, inasmuch as the quality of the product depends in great measure on the treatment which the leaves undergo during the operation, since it is during drying that that fine colour becomes fixed, with simultaneous production of that delicate flavour and agreeable taste which are wanting in the original leaves; so that it requires excellent workmen, whose requisite skill is only attained after a long practice.

The drying is conducted in a shallow rectangular box, the bottom of which is made of a thick paper stiffened with starch. The box is placed over a copper-wire gauze supported by iron bars, which are provided across the furnace. The furnace is simply a rectangular box coated with clay, and has the depth of 2·5 shaku.

To begin the operation, first of all a charcoal fire is made in the furnace. The rectangular box is now placed over it, the leaves are next introduced into the box, and the workman continually rubs them between the hands, alternately tossing them up and letting them fall until they are nearly dried. Thus dried the leaves are further dried by keeping for a night in the same furnace after the charcoal fire is withdrawn. In large factories numbers of these furnaces are arranged in rows, and during the drying each furnace is attended by one workman.

The tea thus dried is, before it is sent to the market, subjected to sorting and sieving. The sorting simply consists in spreading out a certain quantity of tea upon a flat table, and in removing dust, stems, and other foreign matters by picking them up, which operation is usually done by women and girls. The sorted tea is then sieved.

The sieves of different meshes are distinguished from one another by the numbers 1, 2, 3, &c., and the number of sievings as well as the sieves used vary with the quality of the tea. Thus, in the case of coarse kinds, it is passed twice or thrice through each of 1 and 2, and in the best kinds only once through 2, 3, 4, and twice through 3, which has the meshes of nearly 3 millimetres. The tea thus prepared is preserved in earthenware or metallic pots in order to preserve it from the moisture.

Black Tea.

Before intercourse with Western nations was opened this was scarcely known to us, but now at present it is manufactured, though to a very limited extent, for the purpose of exporting it to foreign countries.

The writer states the following description of the process to be due to the Report published by order of the Board for promotion of industry, agriculture, and commerce.

In preparing the black tea, the leaves from wild tea-

Analysis of Japanese Teas.

Name.	Moisture.	Ash. Soluble.	Ash. Insoluble.	Ash. Total.	Organic Matter. Soluble.	Organic Matter. Insoluble.	Organic Matter. Total.	Total Extract.	Nitrogen.	Yens per Kin.
Shimonohaua ..	9·27	3·86	1·18	5·04	35·96	50·74	86·70	39·82	4·24	0·24
Toyokumo	9·97	3·74	1·20	4·94	37·06	46 03	85·09	42·70	4·14	0·25
Hochayen	9·38	2·66	2·72	5·38	34·14	51·10	85·24	36·80	3·90	0·50
Kiuimosato.. ..	7·66	4·35	1·26	5·61	38·40	48·33	86·73	42·75	—	1·25
Nagauotomo ..	8·71	4·28	1·69	5·97	37·32	48·00	85·32	41·60	5·37	1·50
Toyokage	8·81	3·88	1·68	5·56	40·40	45·23	85·63	44·28	—	2·50
Toyomaye	8·31	3·41	1 32	4·73	41·87	45·09	86·96	45·21	3·87	3·50
Giokuro	6·90	3·45	2·55	6·00	33·55	53·55	87·10	37·00	—	5·00

plants, or those which are cultivated without much care, are used, otherwise there will not be much profit.

The leaves after gathering are scattered on a straw mat, and dried by exposure to air. They are then collected and softened by tossing and clapping between the hands till they become adhesive. The leaves are then made into a number of balls, which are introduced into a large box, which is closed tightly and exposed to the sun for half-an-hour, when it is brought into the house, and allowed to lie in this state for one night. The balls are then taken out, and subjected to the rolling and drying in the same way as in the preparation of green tea. During the operation the workman turns the mass, so as to prevent it from being burnt. This process is continued until the leaves break very easily by simply pressing between the fingers, when they are considered to be perfectly dry. The tea thus produced is freed from impurities and stalks, and separated into different kinds by passing through sieves having meshes of different size.

The specimens he chemically examined are all those prepared in the celebrated tea-producing district Uji, and are supposed to be unadulterated.

The accompanying table gives the result of the analyses. On examining the table there seems to be no connection between commercial quality and chemical composition, but it is very interesting to observe how nearly the same is the amount of the constituents in all specimens; so that, in any instance, if we find some of the constituents as ash, for instance, in quantity differing from those found in the table, we may consider such specimen as being previously adulterated.

Nitrogen in the table was determined by Dumas's method.

Theine.—He estimates this most important constituent of tea by the following method:—15 grms. of powdered tea are mixed with an equal amount of magnesia, and the mixture is boiled with water, filtered, and residue washed with hot water. The filtrate being evaporated to dryness is exhausted with hot benzole, and the extract is then evaporated and the residue is weighed. By this method he found 0·189 per cent in *Nagauotomo*, and 0·207 per cent in *Horiu*, all brought from Uji.

Analysis of Tea Ash.

	Green Tea from Uji. I.	Green Tea from Uji. II.	Black Tea from Settsu. III.	Black Tea from Settsu. IV.
Silica	8·91	6·19	5·01	4·61
Sulphuric acid	3·87	4·70	3·03	4·22
Phosphoric acid	16·62	17·02	21·87	19·77
Chlorine	1·62	1·95	1·26	1·04
Carbonic acid	7·82	9·45	6·23	7·02
Oxide of iron and alumina	8·21	9·06	6·35	7·96
Manganese sesquioxide ..	0·59	trace	0·98	1·30
Lime	14·57	13·17	8·33	10·42
Magnesia	6·95	6·17	6·92	7·00
Soda	2·70	4·03	5·01	2·99
Potash	27·92	28·11	35·04	33·60
	99·78	99·86	100·03	99·93

Tannin.—This is determined by a standard solution of plumbic acetate. In six specimens from Uji he found the following amounts:—Toyonokumo, 16 per cent; Toyokague, 16·25 per cent; Shimonohaua, 15·62 per cent; Nagauotomo, 14·70 per cent; Toyomaye, 16·70 per cent; Hochayen, 16·12 per cent.

Gum.—Estimated by evaporating the aqueous extract of tea almost to dryness, treating the residue with methyl spirit, the extract evaporated to dryness, and the residue weighed, which, after ignition is again weighed; the loss represents the gum. By this method he found the following amounts in the same specimens as above:—Toyokumo, 13·72 per cent; Toyokage, 9·75 per cent; Shimonohaua, 12·32 per cent; Nagauotomo, 10·10 per cent, Toyoumaye, 9·90 per cent; Hochayen, 10·61 per cent.

Japanese Tobacco.

There are various varieties of tobacco plant, differing more or less in the form and size of the leaf, but those growing in this country are known as *Nicotiana Chinensis*, and *Nicotiana Tabacum*, bearing rose-coloured flower, and growing to the height of 3 to 5 feet. The tobacco plant is cultivated almost in every province, but the best leaves are produced in the provinces of Hizeu, Hitachi, Satsuma, and Nagato.

The mode of collecting the leaves varies in different places, but generally two or three small leaves, which are situated at the upper part of the stem, are first taken off by hand, and the remaining leaves, after being exposed to the sun for 3 to 5 days, are successively taken, three or four at a time. In Awa it is just reversed; the lower leaves, which are of inferior quality, are taken off at first in June, when the leaves are slightly yellowish, and the middle leaves, which form the best sorts, are collected after 13 or 14 days. In some places a second crop is obtained from new shoots, which, if properly cultivated, yield leaves which are not inferior to those of the first gathering.

The leaves thus collected are placed on a floor covered with a straw mat, allowed to remain for one or two days, when the mat is taken off; those which have assumed the melon-yellow colour are sorted out and dried by exposure to air, while those still retaining the original colour are kept in the same condition till the required colour is developed.

The dried leaves are now packed and sent to market. According to Japanese fashion, tobacco for smoking purposes is cut into fine threads.

Analysis of Tobacco Leaves.

	Province of Production. Nagato. Per cent.	Shimozuki. Per cent.	Settsu. Per cent.	Osumi. Per cent.
Water	6·41	10·01	7·63	13·18
Ash	15 76	8·45	20·71	9·80
Nicotine	2·45	3·02	3·92	1·89
Acetic acid ..	0·05	0·04	0·01	0·08
Oxalic ,, ..	trace	0·27	0·25	trace
Malic ,, ..	0·79	1·02	1·83	2·98
Citric ,, ..	0·52	0·59	0·92	0·89
Pectic ,, ..	1·24	5·84	7·42	2·35

The methods he used for the determination of nicotine and organic acids are as follows:—

1. *Nicotine.*—10 grms. of powdered tobacco are made alkaline by ammonia which is intended to displace nico-

tine. It is then extracted by ether, the extract evaporated to dryness, when a pasty residue of nicotine and a geenish yellow resinous body is obtained from which nicotine is determined by standard sulphuric acid.

Acetic Acid.—Tobacco powder is moistened with water and then ground with tartaric acid. The mass is exhausted with steam, which volatilises acetic acid, and which is condensed by means of Liebig's condenser. The acid is determined by means of standard alkaline solution.

3. *Oxalic, Malic, and Citric Acids.*—10 grms. of tobacco are moistened with hydric sulphate, the quantity to be used being previously calculated from the ash of the leaves. It is then exhausted with ether in a continuous distillation apparatus. The organic acids are dissolved in ether and the operation is completed when a small quantity of ether, evaporated, does not leave any residue.

In order to extract the required acids, leaving the foreign bodies in ether solution, a few drops of water are added and the whole is shaken. The aqueous solution is separated from ether solution, and the water solution is neutralised by ammonia, and a few drops of acetic acid is added. Then the oxalic acid is precipitated by a dilute solution of calcic acetate and determined.

To the filtrate a dilute solution of lead acetate is added until a permanent precipitate appears, and about 1 c.c. of the supernatant liquid is taken into a test-glass, and a drop of very dilute lead acetate solution is added; if the precipitate produced is not dissolved by addition of a few drops of acetic acid, then after 1 c.c. taken is returned to the main portion the addition of lead acetate is continued. This is repeated till a precipitate, produced by a new addition of lead acetate, is completely soluble in hydric acetate. Then it is filtered, washed with water containing a small quantity of lead acetate and acetic acid, and finally with alcohol at 36°. The washings are kept separate from the main filtrate. Citric acid is then determined from the lead oxide left after combustion of the precipitate. In the washings a small quantity of citric and malic acids are present; they are precipitated, after alcohol is expelled, by adding an excess of lead acetate, and their amounts are determined from the quantity of lead oxide, assuming the two acids to be present in equal proportions.

In the filtrate malic acid is precipitated by adding an excess of lead acetate solution, and the precipitate is treated as in case of citric acid.

4. *Pectic Acid.*—10 grms. of powdered tobacco are exhausted with alcohol at 36° containing 1·4th its volume of concentrated hydric chloride until the filtered liquid no longer contains lime. The residue is washed with alcohol so as to remove hydric chloride completely, and it is then treated with a solution containing a known quantity of ammonium oxalate, by which pectic acid is dissolved out. After two hours' digestion at 35°, it is filtered, the residue washed, the filtrate made to 1 litre, from which a known volume is measured out, and an excess of calcic acetate is added, when a white precipitate of oxalo-pectate of lime is formed, which is filtered on a weighed filter and weighed after drying at 100° C. This precipitate is then burnt, and the amount of lime formed is ascertained. The amount of pectic acid is then calculated from the following:—

$$P = (B - C\tfrac{6}{5}A),$$

where A is the weight of ammonium oxalate, and B that of oxalo-pectate, and C the amount of lime formed on burning oxalo-pectate.

	Province of Production.			
	Nagato.	Shimozuki.	Settsu.	Osumi.
Carbonic acid..	10·20	15·40	10·20	14·86
Sulphuric ,, ..	4·75	3·40	2·02	5·52
Phosph. ,, ..	4·30	5·15	3·32	4·85
Chlorine	11·70	8·23	5·56	4·45
Silica	3·86	5·46	9·55	5·51
$Fe_2O_3+Al_2O_3$..	3·80	2·60	8·17	9·15
Lime	33·12	22·92	23·45	21·95
Magnesia ..	7·98	6·57	8·02	6·78
Potash	13·78	25·52	27·51	24·49
Soda..	6·11	4·18	3·82	1·90
	99·60	99·43	99·62	99·46

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING NOVEMBER 30TH, 1884.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To COLONEL SIR FRANCIS BOLTON, *Water Examiner, Metropolis Water Act, 1871.*

London, December 6th, 1884.

SIR,—We submit herewith the results of our analyses of the 172 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from November 1st to November 29th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of the 172 samples, all excepting one that was recorded as "*slightly turbid*," were found to be perfectly clear, bright, and well-filtered.

The proportions of organic matter in the water supplied by the several Companies during the past month have continued low, and below the average for the season of the year, though not to so exceptional a degree as in the samples examined in the preceding month. In our report for the month of July last we called attention to the circumstance that the habitual slight monthly rise then noticed, in the always small proportion of organic matter present in the water supply of London, was "ordinarily followed by a more decided fall in August and September, to be succeeded, in its turn, by an appreciable rise in October and November." During the past month, however, the mean proportion of organic matter in the water, though above that met with in October, can scarcely be said to have manifested as yet the "appreciable rise" usually noticeable in the early winter months.

We are, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

THE COMPOSITION AND METHODS OF ANALYSIS OF HUMAN MILK.*

By Prof. ALBERT R. LEEDS, Ph.D.

(Concluded from p. 291).

IV. *Nationality.*—The statistics are entirely too meagre to determine the influence of nationality. It would be

* Read by invitation, before the College of Physicians of Philadelphia, May 7th, 1884, and reprinted by permission from advance-sheets of its Transactions.

TABLE VI.—MILK OF WOMEN FROM FIRST TO ELEVENTH DAY OF LACTATION.

A = No. of cases above or below the general average.
B = Averages for A.
C = Averages from the first to eleventh day of lactation.
D = General averages from the 1st to 270th day of lactation.

No. of sample.	Day.	Albuminoids		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
		Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Above av.	Below av.
13	1	2.40	.....	.....	6.45	6.01	.....	.....	9.07	0.22	.....	15.07	
14	1	2.52	.....	.....	6.44	4.95	.....	9.23	.....	0.27	.....	14.16	
7	2	3.12	.....	.....	6.47	5.49	.....	9.91	.....	0.32	.....	15.35	
47	2	4.86	.....	.....	5.40	.....	3.36	9.46	.....	.....	0.20	13.35	
6	2	.....	1.45	7.24	.....	.....	3.20	.....	8.93	0.24	.....	.....	12.10
38	2	.....	1.82	6.96	.....	.....	3.97	.....	8.97	.....	0.19	.....	12.87
15	3	2.18	.....	.....	6.75	.....	2.84	.....	9.06	.....	0.13	.....	11.88
40	3	.....	1.75	.....	6.94	.....	3.68	.....	8.97	0.28	.....	.....	12.52
64	3	2.00	.....	.....	6.69	.....	3.96	.....	9.01	0.32	.....	13.05	
8	4	2.15	.....	.....	6.51	.....	2.31	.....	8.94	0.28	.....	.....	11.40
16	5	.....	0.85	.....	5.50	6.16	.....	.....	6.57	0.22	.....	.....	12.73
45	5	2.33	.....	7.48	.....	.....	2.47	9.97	.....	.....	0.16	.....	12.36
67	5	.....	1.96	7.28	.....	4.74	.....	9.54	.....	0.30	.....	14.28	
18	6	3.95	.....	7.92	.....	4.37	.....	12.09	.....	0.22	.....	16.55	
41	6	2.45	.....	.....	6.08	.....	3.82	.....	8.72	.....	0.19	.....	12.41
21	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.01
32	10	.....	1.53	.....	5.84	5.62	.....	.....	7.21	.....	0.14	.....	12.99
34	10	2.19	.....	7.46	.....	6.89	.....	9.90	.....	0.25	.....	16.66	
A		XI.	VI.	VI.	XI.	VIII.	IX.	VII.	X.	XI.	VI.	VIII.	X.
B		2.74	1.56	7.40	6.28	5.53	3.29	10.01	8.54	0.26	0.17	14.81	12.43
C		2.32		6.67		4.93		9.15		0.23		13.48	
D		1.995		6.936		4.131		9.137		0.201		13.267	

TABLE VII.—MILK OF WOMEN FROM THE 11TH TO 31ST DAY OF LACTATION.

No. of sample.	Day.	Albuminoids		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
		Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Above av.	Below av.
33	11	2.24	.....	.....	6.25	.....	2.76	.....	8.84	0.35	.....	.....	11.45
65	12	2.25	.....	7.12	.....	5.85	.....	9.52	.....	.....	0.15	15.35	
26	13	2.08	.....	6.98	.....	.....	3.28	9.26	.....	.....	0.20	.....	12.39
4	13	.....	1.73	7.25	.....	.....	2.95	9.19	.....	.....	0.18	.....	11.96
39	13	2.33	.....	.....	5.78	4.21	.....	.....	8.32	0.21	.....	.....	12.57
29	17	.....	1.81	.....	6.88	.....	2.80	.....	8.89	.....	0.20	14.69	
48	17	.....	1.93	.....	.....	5.59	.....	.....	9.06	.....	0.18	14.58	
28	19	2.23	.....	7.39	.....	.....	2.95	9.83	.....	0.21	.....	.....	12.95
31	19	2.27	.....	.....	6.75	5.96	.....	9.17	.....	.....	0.15	15.21	
24	20	.....	1.94	7.45	.....	.....	3.61	9.56	.....	.....	0.16	.....	13.02
9	22	2.05	.....	7.08	.....	.....	3.00	9.26	.....	.....	0.13	.....	12.31
51	23	2.42	.....	6.95	.....	5.60	.....	9.56	.....	.....	0.19	15.25	
68	23	2.17	.....	7.44	.....	4.36	.....	9.90	.....	0.29	.....	14.26	
3	25	.....	1.96	7.31	.....	4.62	.....	9.45	.....	.....	0.18	13.96	
5	26	.....	1.49	7.23	.....	.....	2.12	.....	8.90	.....	0.18	.....	11.11
60-3	26	.....	1.95	7.02	.....	.....	3.85	9.19	.....	0.22	.....	.....	13.12
2	27	.....	1.68	7.53	.....	.....	3.55	9.42	.....	0.21	.....	.....	12.84
30	27	2.11	.....	7.41	.....	5.04	.....	9.72	.....	.....	0.20	14.69	
35	29	2.43	.....	7.34	.....	.....	3.13	9.98	.....	0.21	.....	.....	13.20
66	30	.....	1.11	7.07	.....	.....	2.73	.....	8.40	0.22	.....	.....	11.13
A		XI.	IX.	XVI.	IV.	VIII.	XII.	XIV.	VI.	VIII.	XII.	VIII.	XII.
B		2.23	1.76	7.22	6.42	5.02	3.23	9.50	8.74	0.24	0.17	14.75	12.25
C		2.09		7.06		4.00		9.27		0.201		13.25	
D		1.995		6.936		4.131		9.137		0.201		13.267	

necessary to obtain for each race a large collection of results, in which the other causes of variation, like age, period of lactation, &c., were allowed for or eliminated. This has never been done, and would require, not eighty, but many hundred analyses.

The difficulty of generalisation upon these points can

TABLE VIII.—MILK OF WOMEN FROM THE 31ST TO 91ST DAY OF LACTATION.

No. of sample.	Day.	Albuminoids		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
		Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Above av.	Below av.
12	41	.....	1.76	6.97	.....	.....	2.44	.....	8.93	.....	0.20	.....	11.40
1	45	.....	1.44	7.20	.....	5.58	.....	.....	8.81	.....	0.17	14.46	.....
17	49	.....	1.49	7.37	.....	5.02	.....	.....	9.03	.....	0.17	14.18	.....
11	18	.....	1.98	6.99	.....	.....	3.06	9.17	.....	.....	0.20	.....	12.21
20	50	.....	.....	.....	.....	.....	.....	.....	.....	0.30	.....	14.08	.....
23	53	2.10	.....	.....	6.61	.....	4.02	.....	8.91	.....	0.20	.....	12.88
10	82	.....	1.45	7.19	.....	.....	2.11	.....	8.81	.....	0.19	.....	10.91
53	88	.....	1.82	.....	6.83	4.28	.....	.....	9.02	0.37	.....	13.30	.....
27	89	1.98	.....	7.00	.....	.....	2.44	9.19	.....	0.21	.....	.....	11.84
52	90	2.15	.....	.....	6.76	6.78	.....	.....	9.07	.....	0.16	15.89	.....
A		III.	VI.	VI.	III.	IV.	V.	II.	VII.	III.	VII.	V.	V.
B		2.07	1.66	7.12	6.73	5.41	2.81	9.18	8.94	0.29	0.18	14.38	11.85
C		1.60		6.99		3.97		8.99		0.22		13.11	
D		1.995		6.936		4.131		9.137		0.201		13.267	

TABLE IX.—MILK OF WOMEN FROM THE 91ST DAY TO THE 10TH MONTH OF LACTATION.

No. of sample.	Day.	Albuminoids		Milk-sugar.		Fat.		Solids not fat.		Ash.		Total solids.	
		Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Ab'ye av.	Bel'w av.	Above av.	Below av.
55	93	2.43	.....	.....	6.57	4.94	.....	9.27	.....	0.27	.....	14.20	
25	115	2.16	.....	7.00	.....	5.84	.....	9.38	.....	0.22	.....	15.18	
19	126	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	.....	12.34
54	132	.....	1.50	7.34	.....	.....	3.10	.....	8.92	.....	0.18	.....	12.12
56-9	136	.....	1.16	7.41	.....	4.79	.....	.....	8.78	0.21	.....	13.63	
43	150	.....	1.50	7.32	.....	.....	3.77	.....	9.00	.....	0.18	.....	12.64
42	167	.....	1.97	7.38	.....	4.16	.....	9.60	.....	0.25	.....	13.60	
22	180	.....	.....	.....	.....	.....	.....	.....	.....	0.21	.....	.....	12.74
44	180	.....	1.49	7.31	.....	4.34	.....	.....	9.01	0.21	.....	.....	13.17
46	186	.....	1.35	7.24	.....	.....	4.09	.....	8.89	0.30	.....	.....	13.15
50	217	2.06	.....	.....	6.39	4.75	.....	.....	8.67	0.22	.....	13.48	
49	270	2.00	.....	6.95	.....	4.64	.....	9.16	.....	0.21	.....	13.74	
A		IV.	VI.	VIII.	II.	VII.	III.	IV.	VI.	IX.	III.	VI.	VI.
B		2.16	1.50	7.24	6.48	4.78	3.65	9.35	8.88	0.23	0.17	13.97	12.69
C		1.78		7.09		4.44		9.07		0.22		13.34	
D		1.995		6.936		4.131		9.137		0.201		13.267	

be most forcibly illustrated by comparing the analysis of sample No. 40, which was obtained from a negress, with the other samples, and with the general average. Neither in colour, smell, nor other physical characteristics, nor in chemical constitution, was this one sample so markedly different from the others as to be put, as some have proposed to do with the milk of negro women, in a class by itself.

V. *Physical Constitution of the Mother.*—A comparison of the physical characteristics of the mother, whether blonde or brunette, or more minutely as to colour of eyes, hair, complexion, &c., has not shown that these differences are necessarily related to corresponding differenbes in the composition of the milk. But actual differences in the physical condition of the mother are intimately related. The samples obtained from women of over-robust habit were not so rich in albumenoids as those from pronouncedly anæmic women; and, generally speaking, the best milk was obtained from lean women in good physical condition.

Certain Spectroscopic Procedures.—Eug. Demarçay.—In place of the method of Lecoq de Boisbaudran the author uses the induction spark obtained from a coil with a thick and short induction wire.—*Compees Rendus.*

THE SPECTROSCOPIC EXAMINATION OF THE VAPOURS EVOLVED ON HEATING IRON, &c., AT ATMOSPHERIC PRESSURE.

By JOHN PARRY, Ebbw Vale.

METALLURGISTS favoured with opportunities of observing the behaviour of metals whilst being heated or fused are of opinion that the fumes usually seen are due to the volatilisation of the metal itself, or of some more volatile constituent.

In casting alloys of the more fusible metals, this dissociation or volatilisation is an accepted fact, and is usually considered when adjusting the proportions of the constituents. Alloys of the more infusible metals, such as iron, manganese, nickel, cobalt, &c., have not been studied; but those who have observed the behaviour of crude iron and steel whilst being fused, or otherwise manipulated at high temperatures, have noted that, in addition to the well-known evolution of gas, fumes are given off, which has led to the inference that, as before stated, some more volatile constituent is being evolved;

and Professor Ledebur asserts that as iron is being volatilised the chemical composition of the metal may be changed, presumably within certain narrow limits. It may be that crude iron is slowly dissociated, and certainly at the high temperature of the Bessemer process iron is volatilised, and may be seen far above the mouth of the converter, forming a red cloud, quite unlike ordinary smoke or vapour.

The spectroscopic examination of the flames issuing from blast and other furnaces show only continuous spectra, with but few lines, very similar to the spectrum of the ordinary Bunsen flame, with the exception of the Bessemer flame, which gives the carbon spectrum, together with (according to some observers) that of manganese.

I have, however, found that many of the metals are volatilised at a comparatively low temperature, but give only continuous spectra when examined in the flame. The vapour requires the intense heat of the electric spark to be passed through it to ensure complete dissociation, and consequent production of the usual line spectra. (A list of metals tested is attached hereto.)

Spiegeleisen fused in a crucible evolved a fume in which I detected zinc, copper, manganese, calcium, and, with less certainty, magnesium.

Bessemer pig-iron, similarly treated, gave copper, manganese, calcium, either lead or arsenic, as well as gas burning with a flame resembling that of carbonic acid.

Bessemer pig-iron burnt in a stream of oxygen at a dull red heat gave copper, manganese, &c., as before, but more intensely; also a great number of lines which appear to be derived from iron. This spectrum requires careful study, and, when developed, may throw some light on the reactions occurring during the Bessemer blow.

Spanish iron ore reduced in a crucible with charcoal, at a heat sufficient to form a button of fused metal, evolved zinc, copper, and manganese.

It is therefore probable that matter may be evolved during the ordinary heating processes in the manufacture of iron and steel, as previously explained, but giving no visible indications of the fact, in consequence of the heat being sufficient only to volatilise without effecting dissociation.

With my present limited experience, I am of opinion that the actual quantity of matter evolved from iron, steel, &c., is very small, and not at all likely to affect the quality of the coarser kinds of iron and steel, although it may be otherwise when a material of good quality and great purity is required.

The germ of the foregoing is to be found in the recent work of spectroscopists, more especially of Mr. Lockyer, who, in his "Studies in Spectrum Analysis"—a volume abounding with suggestions which should, in my opinion, be carefully studied by those practically engaged in the iron manufacture—says, "Depend upon it, that as spectroscopy becomes the daily work of iron founders and the like, it will be found to be bristling with scientific truth which may be used in these practical applications."

Note.—Spanish iron ore evaporated to dryness with hydrochloric acid. The dried chlorides were carefully and gradually heated in the blowpipe, and copper, zinc, calcium, barium, lead, silver, and manganese lines successively detected in volatilised chlorides. At the highest obtainable heat iron lines are seen.

The impure ferric chlorides, obtained by digesting steel or iron in hydrochloric acid and evaporating to dryness, heated as above, shows—1st, copper and calcium; 2nd, manganese; next, with less certainty, chromium and magnesium. On increasing the heat the iron spectrum is vividly seen.

Steel or iron filings, mixed with ammonium chloride, and heated also, gives the foregoing series of spectra, which last longer, and may be repeated by successive additions of the chloride.

Very fine spectra of sulphur and phosphorus may be obtained by slightly heating either on a moderately hot plate of iron, placed just below the spark from the coil.

Notes on the Volatility of the Metals Heated in Crucibles. Fletcher's "Injector Blowpipe" used.

Thallium.—Very volatile. Seen in flame and spark above.
Arsenic.—Very volatile. Seen in spark only.
Copper.—Very volatile. Volatilised from most metals in flame and spark.
Cadmium.—Easily volatilised. Seen in spark only.
Zinc.—Easily volatilised. Seen in spark only.
Bismuth.—Volatilised at highest red heat. Seen in spark only.
Antimony.—Easily volatilised. Seen in spark only.
Potassium.—Easily volatilised. In flame and spark.
Sodium.—Easily volatilised. In flame and spark.
Tin.—Volatilised at highest temperature of blowpipe. Spark only.
Lead.—Volatilised at lower temperature than tin. Spark only.
Silver.—Not volatile. Copper spectrum seen. Spark only.
Gold.—Not volatile. Copper spectrum seen. Spark only.
Chromium.—Not volatile. Copper spectrum seen. Spark only.
Manganese.—Volatilised with difficulty. Spark only.
Aluminium.—Volatile. Spark only.
Selenium.—Very volatile. Spectra require further study.
Tellurium.—Very volatile. Spectra require further study.
Phosphorus.—Easily volatilised on hot plate. Good spark spectrum.
Sulphur.—Easily volatilised on hot plate. Good spark spectrum.

Notes of Experiments on the Spark Spectra of the Chlorides of the Metals and Alkalies Volatilised at Atmospheric Pressure.

The chlorides of lithium, strontium, copper, and calcium are volatile in the flame of an ordinary alcohol lamp, showing the characteristic spectral lines in the spark about one inch above the flame.

Zinc, barium, copper, and magnesium chlorides are also faintly seen. Query about arsenic? Filter-paper moistened with zinc chloride and placed in the alcoholic flame gave the line W. L. 4809.

Steel filings, mixed with ammonium chloride and heated—copper and manganese first appear, next calcium (zinc?), next iron spectra; after heating thirty minutes only, one copper and two manganese lines are seen. Iron lines nearly gone; calcium seen. Further heated thirty minutes, only calcium; traces of copper flashing out.

Spiegeleisen as above; in addition, magnesium seen; brighter spectrum throughout.

Copper chloride mixed with ammonium chloride and heated with spirit-lamp in a glass tube 20 inches long—copper distinctly seen in the spark at the top of the tube.

Impure steel chlorides, as above, heated in glass tube 4 inches long, spark at top—calcium first seen, copper, next manganese group. After heating some time, only calcium and copper were visible.

Ordinary nickel, cobalt, bismuth, tin, and antimony, show copper spectrum when heated. All metals hitherto tested evolve copper.

Query zinc in steel?

Query magnesium in spiegel? Only first line of magnesium seen on edge of nitrogen line, W. L. 5712.

Compared this line with magnesium, by clamping cross wires down on it; magnesium line distinctly seen on edge of nitrogen, W. L. 5712.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, December 18, 1884.

Dr. Russell, F.R.S., in the Chair.

The following certificates were read for the first time:—N. F. Dutton, R. Dormer, A. G. Green, G. G. Henderson, W. A. Wrenn, A. C. Wilson, A. C. Young, H. H. Whitehead.

During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Messrs. Wilson and Cresswell, to be duly elected Fellows of the Society:—W. P. Ashe, Sir B. V. S. Brodie, Bart., W. Briggs, J .F. Ballard, M. T. Buchanan, W. G. Brown, H. M. Chapman, W. H. Eley, J. Frost, T. P. Hall, H. J. Hodges, H. Jackson, F. Johnson, J. D. Johnstone, G. F. Kendall, C. W. Low, F. M. Mercer, P. C. Porter, V. E. Perez, A. Rickard, K. B. B. Sorabji, R. R. Steele, H. Smith, E. G. Smith, G. Thorn, W. Tate, P. C. Thomas, T. Wilton, J. H. Worrall, W. C. Wise, W. H. Wood.

The Secretary then read the following paper:—

"*Chemico-Physiological Investigations on the Cephalopod Liver and its Identity as a True Pancreas*," by A. B. Griffiths. The author has carefully dissected out this organ from a fresh cuttle-fish. He finds that a small portion of the organ converted starch-paste into dextrose; the organ was alkaline, it emulsified oil, and rendered milk transparent. Under the microscope a small portion gave a brown deposit with iodine, and a yellow colour with nitric acid. The author obtained a glycerin extract of the organ in the usual way, and precipitated a ferment from the glycerin solution by alcohol. This ferment converted starch into dextrose, and formed from the fibrin taken from the muscular fibres of a young mouse leucin and tyrosin, the latter body giving with a neutral solution of mercuric nitrate a red precipitate, which reaction is stated by the author to be characteristic of tyrosin. The author could not detect any bile acids or glycogen, and concludes that the organ is more like a pancreas than a liver.

The Society then adjourned to Jan. 15, when a paper "On the Atomic Weight of Titanium" will be read by Prof. Thorpe.

It was announced that a lecture would be given by Dr. Frankland, probably in February, "On Chemical Changes produced by Micro-Organisms."

NOTICES OF BOOKS.

The Art of Leather Manufacture. Being a Practical Handbook in which the Operations of Tanning, Currying, and Leather Dressing are fully described, the Principles of Tanning Explained, and many Recent Processes Introduced, as also Methods for the Estimation of Tannin, and a Description of the Arts of Glue-boiling, Gut-dressing, &c. By Alexander Watt. London: Crosby Lockwood and Co.

The author is, we believe, perfectly correct in saying that hitherto no English work on the important arts in question has existed. He deserves, therefore, praise for endeavouring to supply this deficiency in our technical literature. After a historical introduction, in which reference is made to the oppressive interference of the Excise up to the year 1830, the author expounds the chemistry of the dyeing process. After describing gelatin and its behaviour with tannin, he reproduces Seguin's theory of the art, but points out many of his errors, especially his ascription of an important part to gallic acid. He points out the superiority of the leathers made on the slow process by the older tanners as compared with the generality of the superficially-tanned quick-process leathers of the present day.

The author next proceeds to a general description of the skins of animals. Those tissues of animals which are capable of being converted into gelatin by boiling, he terms "gelatinous," instead of "gelatiginous." In the next chapter, which is devoted to an account of the various classes of hides occurring in commerce, Mr. Watt quotes from "The World of Insects," though without assenting to it, the following absurd statement:—"Indeed, tanners prefer hides that have the greatest number of bot holes, considering them the strongest and best, which indeed they are, as the gadfly never attacks any but young and healthy subjects." Common sense, independent of any special experience, must tell everyone that holes in a hide seriously diminish its value. In fact, as the author tells us, how to get rid of these holes has been an anxious subject of inquiry, no less for the tanner than for the farmer. He suggests that in the season when the gadfly makes its appearance the backs of cattle should be brushed over with some solution inimical to insects.

We come next to a chapter on tannin, its preparation and reactions. A note on the process of dialysis makes no mention of the fact that animal membranes do not allow the passage of all bodies through their tissue. but keep back some whilst transmitting others. As regards the varieties of tannin, Mr. Watt accepts the view, now generally received, that these bodies, though nearly allied, are not identical.

The table of the proportions of tannin existing in various barks, roots, extracts, &c., cannot be in all cases depended upon. The quantitative determination of tannin has only of late years been brought to an approximately trustworthy state. It would have been well, therefore, if another column had been added showing the dates of the different determinations. The figures here given are, upon the whole, lower than those to be met with elsewhere. Thus we have the tannin in myrobalans quoted as 20 per cent, and that in sumac as 16; whilst in "Spon's Encyclopædia," vol. v., pp. 1987 to 1991, they are stated as containing respectively 30 to 35 and 24 per cent, figures which certainly agree much better with our own experience.

In discussing the gallic fermentation, the author recommends the addition of anti-zymotic agents to prevent this undesirable change in tan-liquors. He remarks that exposure to the air promotes the gallic fermentation, and he accordingly suggests that the present process of "handling" is a mistake.

In the list of tanning materials we find the myrobalan described under the erroneous name of "myrabolam." Its size is stated as varying from that of a small hazel nut to that of the nutmeg, which would make it too small. It is suggested that the valonia might be successfully cultivated in Australia. The same would very probably be the case with sumac. In the extensive list of tanning materials we find the botanical name of the "marsh rosemary" given as *Statice coriaria*. We have always known "marsh-rosemary" as the English name for *Ledum palustre*.

The following chapter contains the methods for the examination of tan-drugs and the determination of tannin. The "barkometer"—sometimes called barktrometer (!)—is necessarily a fallacious instrument, as the specific gravity of a tan-liquor is raised by any constituent existing in solution. The author, indeed, gives the caution that this instrument should be used only for fresh solutions. We have next an account of the methods of Davy, Bell, Stephens, and Hammer, and the more trustworthy procedure of Löwenthal, with its modifications by Mr. F. W. Hewitt and Mr. H. R. Procter.

Preliminary matters having been thus disposed of, Mr. Watt comes to the art of tanning itself. He describes in succession the operations of cleansing and softening the dry hides as received, and the depilation or unhairing

process. Here we find a very necessary caution as regards the use of calcium disulphide. The hydrogen sulphide given off has a very injurious action upon the workmen exposed to it, and may even produce temporary blindness. In the raising process—which when applied to kips and skins is named "bating, puring, or drenching,"—there is a surviving tendency to use unsavoury agents, such as the dung of pigeons or of dogs, made into a paste with water.

After an account of the ordinary methods of tanning butts for sole-leather, we come to notices of patented improvements, some of which are "improvements" only in a "Pickwickian" sense. One ingenious inventor, in order to let the solution of tannin penetrate more readily through the hides, perforates them with fine steel points to the number of 100 to 300 to the square inch. Whether these holes can ever be closed up again so as to be equally watertight with an unpunctured hide is a very doubtful question.

Under the heading "Tanning by Pressure" there follows a description of several processes in which tannin is forced into the hides by pressure. In a section on "quick tanning" the author admits it as demonstrated "almost beyond the shadow of a doubt" that the process of tanning can never be both quick and good. It must be regretted, both with respect to leather and to many other articles, that those who know that a good product is in the long run the cheapest cannot be supplied.

In succession the author speaks of the manufacture of harness, belting, and upper leathers, the American methods of tanning, and hemlock tanning.

Tanning by electricity is next taken up, and though none of the processes devised has as yet achieved any decided success, it would be rash to declare that there is in this direction nothing to hope for.

Knapp's iron tanning and Heinzerling's chrome tanning are next described. Here, again, it is premature to pass judgment upon the results, though, as the author remarks, even if a better leather is produced without tannin the world will not readily believe it.

There are other interesting and important chapters on vegetable leathers, on bleaching leather, on the manufacture of Russia and Morocco leather and cordovans, on dyeing leather, on the manufactures of white leathers, glue making, and gut-dressing.

The work is abundantly illustrated, and contains few typographical errors. Some of the matter quoted appears to have been translated from the German by a writer not too well acquainted with English technical terms. The information which, we believe for the first time, is collected in this volume could only be found by searching through a bulky and costly pile of cyclopædias, technical journals, and patent specifications. Hence we consider that Mr. Watt has rendered an important service to the trade, and no less to the student of technology.

Alkali, &c., Works Regulation Act, 1881. Twentieth Annual Report on Alkali, &c., Works by the Chief Inspector. Proceedings during the Year, 1883. London: Eyre and Spottiswoode.

The issue before us derives a melancholy interest, as being the last report from the pen of the late Chief Inspector, Dr. R. Angus Smith. His protracted illness, indeed, is mentioned in the introduction as a reason why his personal contributions to the "Report" are briefer than heretofore.

The first point to be noticed is that little increase has taken place in the total number of works under inspection, *i.e.*, 990. No fewer than 49 works have been registered for the first time, but several have been closed for a time or permanently, whilst a number of smaller works have ceased making such articles as brought them within the scope of the Act. Of the new works we find that 26 are for the manufacture of sulphate of ammonia, and 12 for chemical manures. These facts and figures certainly go to prove that the chemical arts in the United Kingdom are not making that progress which we might wish to see—a conclusion for which there is unfortunately too much evidence from other sources.

Another general reflection which strikes us is the somewhat one-sided and arbitrary character of the law concerning noxious fumes and gases. Any chemical works emitting aëriform nuisances is placed under strict surveillance; the proprietor is advised and urged—and this may not always be done with the courtesy and tact which distinguished the late Chief Inspector—to make the required improvements, and should he prove unwilling or unable to effect what is considered needful, prosecutions and fines follow. But the sulphurous acid gas evolved in the consumption of coal, whatever may be its quantity, and whatever the injury occasioned to vegetation, passes free. Not only so: the inspector walks past glass- and copper-works well knowing to what an extent they pollute the atmosphere, but without power to interfere.

Thus we find it recorded that land-owners and farmers near Castleford, in the teeth of all evidence, lay the blame of damage done to vegetation on the alkali-works there, although the inspectors show that the glass works evolve 30 tons SO_3 weekly, as against 3 tons SO_3 and 2 tons HCl evolved by the alkali works. Even the damage done by Aphides and other insect-pests is ascribed to chemical manufactures. We remember, indeed, that on one occasion, when a number of ornamental shrubs had been destroyed by a severe frost, a neighbouring manufacturer of dyers' chemicals was threatened with legal proceedings.

Considerable annoyance has in some districts been occasioned by potteries, where during the process of salt-glazing a certain quantity of hydrochloric acid is liberated. It is satisfactory to find that after a course of experiments carried on at the works of Messrs. Doulton at St. Helens and at Lambeth, this evil has been very much abated without interfering with the quality of the glaze produced. On one occasion the quantity of free acid escaping into the air has been reduced as low as 0·11 grain per cubic foot.

We next notice an interesting report on the extraction of ammonia from blast-furnace gases in Scotland,—a question which derives increased importance from the substitution of coal for coke in iron-smelting. This does away with one of the main necessities for the production of coke, and lessens the importance of improved coke-ovens, which permit of the collection of the by-products. Of the matter obtained from the waste gases of blast-furnaces the tar is the least important, as it is found to be poor in those principles from which artificial colours are prepared. The ammonia is of greater value, but, as we are here reminded, its total possibilities are limited. According to calculations made not more than 27,000 tons sulphate of ammonia may be yearly obtained from the waste gases of iron works in Scotland. In England not more than 3000 tons may be expected, as coke is principally employed in the English blast-furnaces.

Two methods of obtaining ammonia, &c., from the furnace gases are here mentioned: The washing of the gases with water in presence of acid, and the washing with water alone after the gases have been sufficiently cooled.

Another important question raised in the same report is the extraction of ammonia from shale in the oil works of Scotland. The shales are exposed to destructive distillation, and after the volatile products have been given off steam, or a mixture of steam and air, is passed over the highly heated residue, with the result that an increased proportion of the nitrogen originally present appears in the form of ammonia.

A similar process has been applied to "coal-dross," with the result of obtaining a lighting gas rich in ammonia and also tar. What "coal-dross" is does not distinctly appear,—probably the term signifies carbonaceous matter too rich in shale to be marketable as coal. From 1 ton of this dross are obtained 172,000 cubic feet

of gas, used as fuel in heating shale retorts, and from 90 to 100 lbs. of sulphate of ammonia. Nothing is said concerning the quality of the tar, which is but scanty.

Concerning the Portland cement works of North Kent and the opposite shore of the Thames there seems a variety of opinion. The fumes given off are exceedingly unsightly, as will have been noticed by every one who has happened to travel from London to Maidstone. The smell seems to us less offensive than that of the "ballast-heaps" which are constantly burning in the northern suburbs of London, no man interfering. The report before us states that "during the later stages (of cement burning) the amount of carbonic oxide is large, and, to those close by and inhaling it, poisonous." There seems to be no evidence that the fumes are harmful to vegetation. "A garden, often exposed to the white smoke from a number of kilns, did not seem to suffer in the least; both flowers and fruits grew plentifully in it." The cement manufacturers assert that since this business has been established in North Kent the ague has disappeared. The inspector, indeed, points out that ague is disappearing from all parts of the east of England, but he quotes the evidence of Dr. T. Evelyn-Crook, who has practised in Northfleet since 1848, and has been Medical Officer of Health since 1878. This gentleman states that the neighbourhood is now much more healthy than it was in 1848. The present death-rate is only 17·2 per thousand, a fact scarcely compatible with any injurious action of the fumes from the cement works.

From Castleford comes an exceedingly interesting report touching the effects of glass works. It appears that in 1840 the alkali used in the glass manufacture was soda-ash. But about twenty-five years ago salt-cake (sodium sulphate) came into use: it gradually superseded soda-ash, and is now used more extensively—if not alone. Some of the salt-cake used is the acid variety obtained from the manufacture of nitric acid and of "cylinder salts," *i.e.*, the stronger and purer grades of hydrochloric acid. Such cake necessarily gives off much more sulphuric acid than the refined cake obtained from the alkali works. It certainly seems hard that the alkali makers should, as at Castleford, be blamed for the sins of the glass works, and be kept constantly in fear of prosecution. In the report on the south-west Lancashire district it is remarked:—"As, however, at Widnes, and still more at St. Helens, large quantities of acid vapour are thrown off continually from glass and copper works, and very much is produced during the combustion of the enormous amount of coal burnt there, people are not fully aware of the extent to which they have been relieved by the care and skill of the alkali manufacturers."

Attempts have been made to abate the dense black smoke given off from the chimneys of salt works, but so far not with any decided success. The case is peculiar and difficult. We are told, "The coals under the salt-pans are burnt not in a thin bright fire as in a steam-boiler, nor in fire of intense heat as in a metallurgic operation, but in a thick, slow fire, immediately under the salt pan. . . . If a thin, bright fire is kept, the pan suffers quickly, as the bottom is always covered more or less with salt, and also with a hard deposit of lime and magnesia known as pan-scale."

In the manufacture of bleaching-powder a difficulty is experienced. When the operation is finished a quantity—more or less—of free chlorine remains in the chamber, which must be let escape before the workmen can enter. This escape may be fairly viewed as a nuisance, seeing that even at the distance of 200 yards the smell of chlorine is occasionally distressing to the lungs. It seems, therefore, judicious to draw off the residual chlorine from a finished chamber into another chamber freshly charged with lime.

In manure works the fumes given off during the treatment of mineral phosphates with sulphuric acid have now to be absorbed in condensing towers. This regulation is no light burden for the smaller works, especially at a time when, on account of the depression of agriculture, the manure trade is far less remunerative than was once the case.

Concerning sulphuric acid it is remarked that Mr. Menzies, of the Greenbank Alkali Works, has succeeded in boiling down sulphuric acid to full strength in iron stills, obtaining an acid of sp. gr. 1·850, colourless, and nearly free from iron.

The percentage of iron found ranges from 0·006 to 0·022.

The most unsatisfactory feature in the "Alkali Works Regulation Act" is that its provisions are equally stringent in all places. A person who should start some offensive manufacture in the midst of the hop gardens of Kent, in the Isle of Wight, at Bournemouth, or Ilfracombe, would encounter no more severe regulations than if he went to work where all vegetation has been extirpated, or where there are no inhabitants to complain. Surely a law graduated according to the locality would be greatly preferable.

On the Healthy Manufacture of Bread. A Memoir on the System of Dr. Dauglish. By B. W. Richardson, M.D., F.R.S. London: Baillière, Tindall, and Cox.

The distinction between the Dauglish process of bread-making and the ordinary or fermentation method is very simple. In both, carbonic acid is the agent for rendering the bread "light." In the common, traditional method this carbonic acid is generated by the decomposition of part of the flour, whilst Dr. Dauglish generates the gas by the action of sulphuric acid upon chalk, and incorporates it with the dough. It must be confessed that the art of making bread by fermentation as here described, and as practised in London, is decidedly nasty. Many of its offensive features, however, are merely incidental. There is nothing in the fermentation-process *per se* which compels the bakehouse to be an underground locality. "Making the dough" might, in large establishments, be performed by machinery instead of by the hands and arms of workmen not too cleanly. There is also no necessity that the men should sleep upon the boards on which the dough is afterwards weighed and moulded into loaves.

Among the evils complained of in the old system of bread manufacture we find mentioned "the necessity for using alum." Elsewhere, too, we read:—"The agent chiefly used in the bakeries has been alum. People think that alum is employed to produce whiteness of bread. That result, if obtained by it, is indirect. The great advantage of alum is to check too rapid fermentation, and it is added practically, in proportion as it is required for that intent." But if alum is necessary in making bread by the fermentation process, how comes it that it is never used in the thousands of North-English households, where the bread used is always made at home? Why should men whose whole time is devoted to this art fail to effect what every Yorkshire housewife can accomplish?

The Dauglish process has, however, many advantages, and its use would probably become universal were it not on account of prejudice.

Tablets of Chemical Analysis. (For the Detection of One Metal and One Acid.) By Armand Semple, B.A., M.B. London: Baillière, Tindall, and Cox.

This little book is certainly not one we should like to see in the hands of a youthful student whose ambition is to be "a chemist." It belongs to the same class as many of the elementary manuals now published in this country, the growth of which we have had frequently to lament in these pages. "Candidates for Examinations" have here placed before them in a series of short tables the methods for detecting a single base and acid, which as far as the

object of the book goes, leaves little to be desired. The simplicity of the arrangement adopted in these tablets is such that it is difficult to conceive how any young student could go wrong in performing the operations. Under mercurous salts we read—"Liquor calcis and all the alkalies throw down a black precipitate ('black wash');" and somewhat similar language is used in other places. Is the work intended for "medical candidates"? A new reaction and compound also we find recorded thus—"$HgCl_2+SnCl_2=HgCl+SnCl_3=Hg+SnCl_4$." Citrates, we are told, "are alkaline, colourless, and soluble."

In such an elementary book as the present it seems to be preposterous to give reactions for chromous and chromic salts, and for cobaltous and cobaltic salts.

Annual Report of the Director of the Mint to the Secretary of the Treasury for the Fiscal Year ending June 30, 1884. Washington: Government Printing Office, 1884.

THIS Report, which, in the main, relates to the operations of the Mints and Assay Offices of the United States, contains, also, a mass of important information collected during the year concerning the monetary statistics of foreign countries, and forms a valuable survey of the state of the coinage of the world. As regards the United States we read that "the coinage of gold was about eight millions less than in the previous year. This was caused in part by the diminished receipt of gold bullion at the San Francisco Mint, where the deposits of gold of domestic production fell off three and a half, and the total deposits of gold about three millions of dollars; and in part by a lessened coinage of gold at Philadelphia, which Mint was principally occupied in manufacturing silver and minor coins." The total coinage executed during the year consisted of ninety-two and a half million pieces, of a value of about fifty-eight million dollars. The parting and refining operations show an increase over last year's, the total values being, approximately, of gold twenty-five million dollars, and of silver fourteen million dollars.

The production of the precious metals in 1883 is estimated at thirty million dollars of gold and forty-six million dollars of silver, which represents a decline from the production of the previous year. "It resulted," the report states, "chiefly from the interruption of hydraulic gold mining in California, in many localities, by mandate of the courts, at the instance of the owners of agricultural lands damaged by the deposit of *débris*, and sediment, in the valleys, and on the bottom lands adjacent to the streams in the lower counties, and from the diminished yield of silver from some of the most productive mines of Arizona and Utah." The total production of twenty-one countries for the calendar year 1883 was 141,479 kilos. of gold and 2,747,785 kilos. of silver.

From reports received from twenty-three countries it is estimated that the value of the total coinage for the year was approximately one hundred and one million dollars in gold, and one hundred and fourteen million dollars in silver. "In the coinage of gold, the United States still stands first, although it coined a much less amount than in the preceding year. Germany follows with a coinage of over twenty-one millions; Australia sixteen millions; and Russia over twelve millions."

"Facts and Figures" concerning the Manufacture of Coke and the Collection of By-products by the Simon-Carvès Process. By J. R. BRECKON.

IT is a lamentable fact that a vast amount of the real wealth of this country, estimated by millions sterling, has been and is still being dissipated in smoke. A small fraction of this loss may possibly be set down as unavoidable in connection with some of our industries. It is, however, undeniable that in some of the greatest manufacturing operations, especially those of a metallurgical character, a considerable fraction of this loss must be looked upon as reckless waste. The manufacturer, so long as he gains a satisfactory return for his invested capital, cares but little whether or not one-fourth of his fuel passes up his chimney, whilst with a little trouble and expense it might be recovered as a marketable article. As a rule, however, he is a "practical man," and innovations are to him enemies.

In no industry in this country more than in the metallurgy of iron has this waste been allowed to continue on a vast scale almost unchecked to within the last few years. The saving processes that have been introduced into this field have been either directly by the collection of the gases, or indirectly by a change in the manufacturing process. There remains, however, an extensive field for the inventor in connection with the coking of coals for our furnaces for the saving of valuable material. In this industry few attempts have been made towards rendering the process economical; few, at least comparatively, when we consider, as this pamphlet tells us, that 14,000,000 tons of coal are anually required to meet the demand for coke.

The great loss connected with the operation of coking as hitherto conducted has been for some years forcing itself upon the notice of our iron-masters, but the great cost of pulling down and re-erecting a new set of ovens in a large establihment, and the want of some more than ordinary enterprising manufacturer whom to imitate have acted as deterring agents in the matter; experimentation in iron manufacturing we know means thousands of pounds. As an incentive to metallurgists this little pamphlet on the Simon-Carvès coking process has been written by Mr. J. R. Breckon, in which he gives a detailed account of these ovens adapted for collecting the "waste" products evolved during the coking of coals, as well as at the same time producing coke of a first class quality, and their cost of erection and working. From this work manufacturers will be able to gain for themselves some idea of the efficiency of the process, which we learn is now being employed in several of the iron districts in this country. In an appendix, the subject is further described in two papers by Mr. Henry Simon, C.E., and Mr. Robert Dixon, reprinted from the *Journal of the Iron and Steel Institute*," the latter gentleman giving the results of his practical experience in working these coking ovens. There are added also several papers by Mr. Watson Smith, F.C.S., that have appeared at different periods bearing on the by-products obtained by condensation from the Simon-Carvès ovens compared with the products obtained from other sources of a similar character.

CORRESPONDENCE.

ESTIMATION OF IRON.

To the Editor of the Chemical News.

SIR,—In the note on the "Estimation of Iron by Potassic Permanganate in presence of Free Hydric Chloride, &c.," Dr. Hood gives no indication of acquaintance with what has been done in the same direction by C. Zimmermann. It is given in the "Reports" of the German Chemical Society (1881, vol. xiv., p. 779), and is a branch from other work.

Zimmermann avoids the injurious influence of free hydrochloric acid on permanganate in the titration of iron, by adding manganese sulphate or chloride to the liquid. It is true that the recommendation is rather that of a manganese salt than of a sulphate, but he prefers the sulphate to the chloride on account of its more powerful action, and on account of the absence of yellow colour.

Zimmermann uses a solution of 100 grms. sulphate of manganese in water, and made up to 500 c.c.

20 c.c. (=4 grms. sulphate) of this solution, he says, is sufficient, even in presence of 50 c.c. free HCl (1·12 sp. gr.),to make the titration of a ferrous solution by potassium permanganate absolutely correct.

This statement is supported by 38 good test-experiments (in some of which $MnCl_2$ is substituted for $MnSO_4$), in which the proportions of iron, water, HCl, and manganese salt are varied.

Zimmermann adds that, in the titration of iron as above, the sulphates of nickel, cobalt, and copper do not prevent the formation of chlorine; and sulphate of zinc acts imperfectly.

Dr. Hood's results with sulphate of magnesium are very interesting, and I trust you will afford me this opportunity of placing the earlier by the side of the more recent experiments.—I am, &c.,

W. H. Deering.

Chemical Dept., Woolwich Arsenal,
December 17, 1884.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcix., No. 23, December 8, 1884.

Hydro-ferrocyanic Acid and the Nitro-prussides.—A. Etard and G. Bémont.—Hydro-ferrocyanic acid, if boiled with water in a barometric apparatus to avoid contact with air is rapidly decomposed into hydrocyanic acid, and a yellowish, dense, crystalline body, the composition of which is represented by the formula—

$$Fe(CN)_6FeH_2+2H_2O.$$

If hydro-ferrocyanic acid is boiled with access of air there is produced not Prussian blue, as commonly stated, but a blue crystalline compound $(FeC_2N_2H_2O)_n$.

Optical Inactivity of the Cellulose of Cotton and on the Rotatory Power of Photographic Gun-Cotton.—A. Béchamp.—The author does not accept the alleged transformation of lignine into amylaceous matter. Whilst soluble starch, which is directly colourable by iodine, has a very high rotatory power, the soluble lignine of cotton, not directly colourable by iodine, has no rotatory power, Its inactivity is absolute, like that of inactive tartaric acid, although this cellulose may, by molecular modification, produce dextro-rotatory substances.

Chemical Studies on the Vegetation of the Sugar-Beet in its Second Year.—H. Leplay.—The sugar contained in the root diminishes progressively, and disappears almost entirely at the ripeness of the seed.

MISCELLANEOUS.

Royal Agricultural College, Cirencester.—Dr. Gilbert, F.R.S, Professor of Rural Economy in the University of Oxford, and the associate of Sir J. B. Lawes in the Rothamstead experimental work, has been offered and has accepted the post of Honorary Professor of Agricultural Chemistry at this college, rendered vacant by the death of the late Dr. Voelcker.

Antwerp International Exhibition, 1885.—Mr. E. A. Grattan, H B.M.'s Consul at Antwerp, has been appointed British Commissioner for the International Exhibition, which is to be held at Antwerp next year, and Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their Agent-General for Great Britain and Ireland. The office of the Agent-General is at 35, Queen Victoria Street, and communications from intending exhibitors should be addressed to him there.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Spongy Iron.—What is the method of manufacturing spongy iron, and what are its properties and uses?—G H. Tucker.

MEETINGS FOR THE WEEK

Saturday, 27th.—Royal Institution, 3. "The Sources of Electricity,' by Professor Tyndall.
Monday, 29th.—London Institution, 5.
Tuesday, 30th.—Royal Institution, 3. "The Sources of Electricity," by Professor Tyndall.
Thursday, Jan. 1st.—London Institution, 5 and 7.
—— Royal Institution, 3. "The Sources of Electricity," by Professor Tyndall.
Friday, 2nd.—Geologists' Association, 8.
Saturday, 3rd.—Royal Institution, 3. "The Sources of Electricity, by Professor Tyndall.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to Charles Rumble and Frederick Sear, Chemists, both of Belmont Works, Battersea, in the County of Surrey, for an invention of "A New or Improved Process for the Separation of Glycerine from Fatty Substances," Dated 5th September, 1883, No. 4264.

NOTICE IS HEREBY GIVEN THAT the said Charles Rumble and Frederick Sear have applied under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, for leave to amend the Specification filed by them in pursuance of the said Letters Patent.

A copy of the Specification as proposed to be amended is open to public inspection at the Patent Office, and full details of the proposed amendment were advertised in the Official Journal of the Patent Office issued on the 5th day of December, 1884, No. 97, page 1264.

Any persons intending to oppose such application must leave particulars in writing of their objections to the proposed amendment at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C., within one month from the date hereof.

Dated this 5th day of December, 1884,

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AFTERNOON LECTURES BEFORE EASTER, 1885.

Lecture Hour Three o'clock p.m.

Professor Henry N. Moseley, M.A., F.R.S.—Five Lectures on "Colonial Animals: their Structure and Life Histories;" on Tuesdays, Jan. 13, 20, 27, Feb. 3, 10. *One Guinea.*

Professor Sidney Colvin, M.A.—Two Lectures on "Museums and National Education;" on Tuesdays, Feb. 17, 24. *Half-a-Guinea.*

Professor Arthur Gamgee, M.D., F.R.S.—Four Lectures on "Digestion" (the subject to be continued after Easter); on Tuesdays, March 3, 10, 17, 24. *One Guinea (including Course after Easter).*

Professor Dewar, M.A., F.R.S., M.R.I.—Eleven Lectures on "The New Chemistry;" on Thursdays, Jan. 15, 22, 29, Feb. 5, 12, 19, 26, March 5, 12, 19, 26. *One Guinea.*

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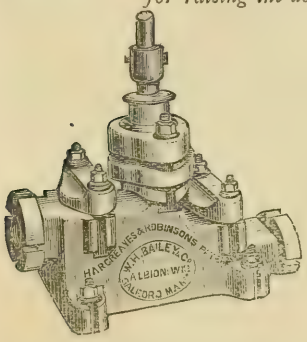

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